

INSTRUCTION MANUAL

**7A18/7A18N
DUAL TRACE
AMPLIFIER**

Serial No. *B020574*



MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES



If you have any questions, your local Tektronix Field Engineer is ready to assist you in instrument selection, operation, application and maintenance. Take advantage of the product knowledge that our staff offers.



PLEASE DETACH CARD BEFORE MAILING

☐ Please have my Tektronix Field Engineer call me at:

TELEPHONE () _____ EXT. _____
Area Code

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

BUSINESS REPLY MAIL

No postage necessary if mailed in the United States

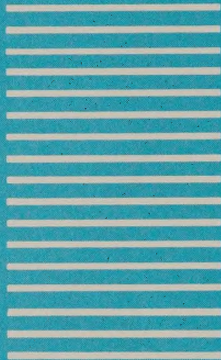
Postage will be paid by

**TEKTRONIX, INC.
Dept. A
P. O. Box 500
Beaverton, Oregon 97005
U.S.A.**

FIRST CLASS

PERMIT NO. 61

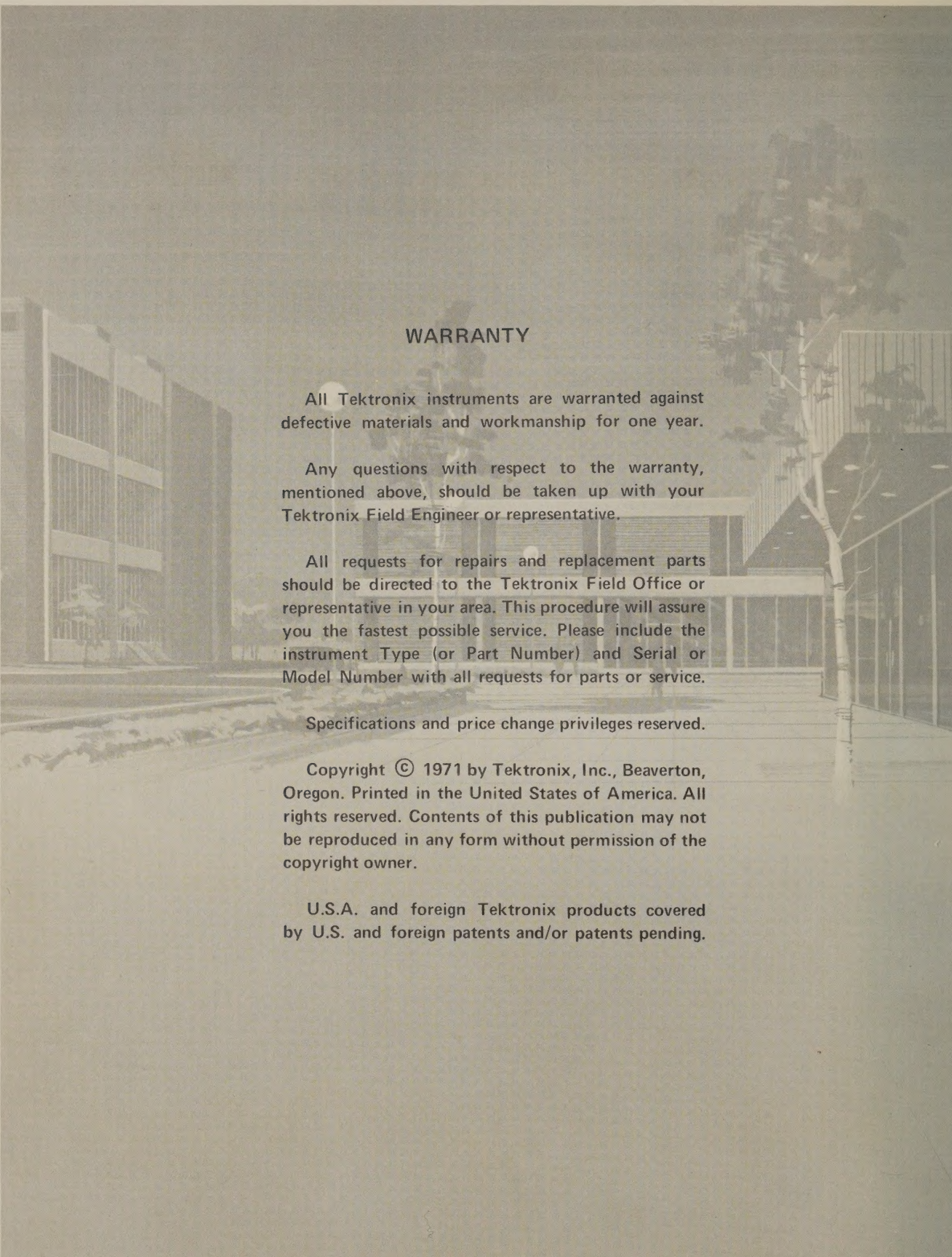
BEAVERTON, OREGON



INSTRUCTION MANUAL

7A18/7A18N DUAL TRACE AMPLIFIER

Serial No. B020574



WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Any questions with respect to the warranty, mentioned above, should be taken up with your Tektronix Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type (or Part Number) and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

Copyright © 1971 by Tektronix, Inc., Beaverton, Oregon. Printed in the United States of America. All rights reserved. Contents of this publication may not be reproduced in any form without permission of the copyright owner.

U.S.A. and foreign Tektronix products covered by U.S. and foreign patents and/or patents pending.

TABLE OF CONTENTS

SECTION 1	SPECIFICATION	Page	SECTION 6	ELECTRICAL PARTS LIST
	Introduction	1-1		Abbreviations and Symbols
	Electrical Characteristics	1-1		Parts Ordering Information
	7A18 And Mainframe Frequency Response	1-3		
	Environmental Characteristics	1-3		
	Physical Characteristics	1-3		
SECTION 2	OPERATING INSTRUCTIONS		SECTION 7	DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS
	Installation	2-1		Symbols and Reference Designators
	Front Panel Controls and Connectors	2-1		Voltage and Waveform Conditions
	General Operating Information	2-2		
	Basic Applications	2-4		
SECTION 3	CIRCUIT DESCRIPTION		SECTION 8	MECHANICAL PARTS LIST
	Introduction	3-1		Mechanical Parts List Information
	Block Diagram Description	3-1		Index of Mechanical Parts Illustrations
	Detailed Circuit Description	3-1		Mechanical Parts List
SECTION 4	MAINTENANCE			Accessories
	Preventive Maintenance	4-1		
	Troubleshooting	4-1		
	Replacement Parts	4-3		
	Component Replacement	4-4		
SECTION 5	CALIBRATION		CHANGE INFORMATION	
	Recalibration Interval	5-1		Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.
	Test Equipment Required	5-1		
	Part I — Performance Check	5-3		
	Part II — Adjustment	5-7		

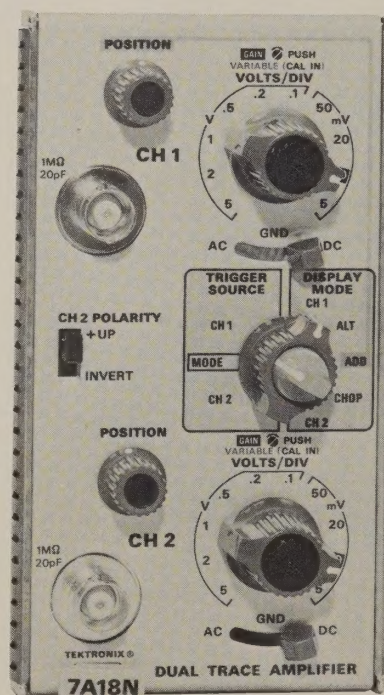
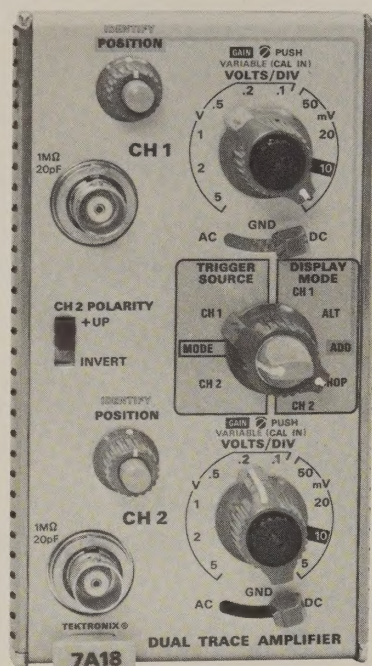


Fig. 1-1. 7A18 and 7A18N Amplifier.

SECTION 1

SPECIFICATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

The 7A18 and 7A18N Dual Trace Amplifier plug-in units are designed for use with Tektronix 7000-Series Oscilloscopes. The 7A18 and 7A18N are electrically identical except that readout encoding capabilities and an "IDENTIFY" function are provided only in the 7A18. All references made to the 7A18 apply equally to the 7A18N unless otherwise noted. The 7A18 is a dual-channel, medium-bandwidth amplifier. Internal gain and compensation circuits are automatically switched to correspond to

the setting of the VOLTS/DIV switch. Channel 2 can be inverted for differential measurements. The 7A18 can be operated in any plug-in compartment of the 7000-Series Oscilloscopes.

The following electrical characteristics are valid over the stated environmental range for instruments calibrated at an ambient temperature of +20°C to +30°C, and after a five minute warmup unless otherwise noted.

TABLE 1-1
ELECTRICAL

Characteristic	Performance Requirement	Supplemental Information
Deflection Factor		
Calibrated Range	5 mV/Div to 5 V/Div; ten steps in a 1, 2, 5 sequence.	
Deflection Factor Accuracy	Within 2% with GAIN adjusted at 10 mV/Div.	
Uncalibrated (VARIABLE)	Continuously variable between calibrated steps; extends deflection factor to at least 12.5 V/Div.	
GAIN		Permits adjustment of deflection factor for calibrated operation with all 7000-series oscilloscopes.
Frequency Response System Dependent (8 div reference signal) Upper Bandwidth DC (Direct) Coupled	See Table A	
Lower Bandwidth AC (Capacitive) Coupled	10 Hertz or less	
With 10X Probe	1 Hertz or less	

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Maximum Input Voltage		
DC Coupled		250 volts, (DC + Peak AC); AC component 500 volts peak-to-peak maximum, one kilohertz or less.
AC Coupled		500 volts, (DC + Peak AC); AC component 500 volts peak-to-peak maximum, one kilohertz or less.
Channel Isolation	50:1 display ratio up to 50 megahertz.	
Input R and C		
Resistance		One megohm within 2%.
Capacitance		20 picofarads within 0.5 picofarad.
Displayed Noise		
(Tangentially Measured)		300 microvolts or less at 5 mV/Div in 7000-Series Oscilloscope.
Overdrive Recovery Time		0.1 ms or less to recover to within one division after the removal of an overdrive signal of up to +75 divisions or -75 divisions regardless of overdrive signal duration.
Common Mode Rejection Ratio	At least 10:1 up to 50 megahertz.	
DC Drift		
Drift with Time (ambient temperature and line voltage constant)		0.02 division or less in any one minute, after one hour warmup.
Drift with Temperature (line voltage constant)		No more than 0.01 division per degree C.
Time Delay between Channels		700 picoseconds or less.
Display Modes	Channel 1 only. Dual-trace, alternate between channels. Added algebraically. Dual-trace chopped between channels. Channel 2 only.	

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Trigger source Selection	Channel 1 only. Follows DISPLAY MODE selection. Channel 2 only.	

TABLE A
7A18 AND MAINFRAME
FREQUENCY RESPONSE

With 7700 Series	With 7500 Series	With 7400 Series
75 MHz	60 MHz	50 MHz

TABLE 1-2
ENVIRONMENTAL CHARACTERISTIC

Refer to the Specification for the associated oscilloscope.

TABLE 1-3
PHYSICAL

Size	Fits all 7000-series plug-in compartments.
Weight	2 Pounds 10 Ounces (1.4 kilograms)

This image shows a single sheet of white paper with horizontal blue or grey ruling lines, typical of notebook paper. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

SECTION 2

OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

General

To effectively use the 7A18, the operation and capabilities of the instrument must be known. This section describes front-panel control functions, general information on signal input connections, and other subjects that pertain to various measurement applications.

Installation

The 7A18 is calibrated and ready for use as received. It can be installed in any compartment of Tektronix 7000-Series oscilloscopes, but is intended for principal use in vertical plug-in compartments. To install, align the upper and lower rails of the 7A18 with the oscilloscope tracks and fully insert it. The front will be flush with the front of the oscilloscope when the 7A18 is fully inserted, and the latch at the bottom-left corner of the 7A18 will be in place against the front panel.

To remove the 7A18, pull on the latch (which is inscribed with the unit identification "7A18" or "7A18N") and the 7A18 will unlatch. Continue pulling on the latch to slide the 7A18 out of the oscilloscope.

FRONT PANEL CONTROLS AND CONNECTORS

The following descriptions apply to the controls and connectors of both Input Amplifier channels when applicable. See Fig. 2-1.

Input Connector	Provides signal connection to the channel.
AC-GND-DC	Selects signal input coupling mode.
	AC—The AC component of the signal is coupled to the amplifier input while the DC component is blocked.
	GND—Grounds the amplifier input while maintaining the same load for the input signal. Provides a charge path for the AC coupling capacitor to precharge the input circuit before switching the input to AC.

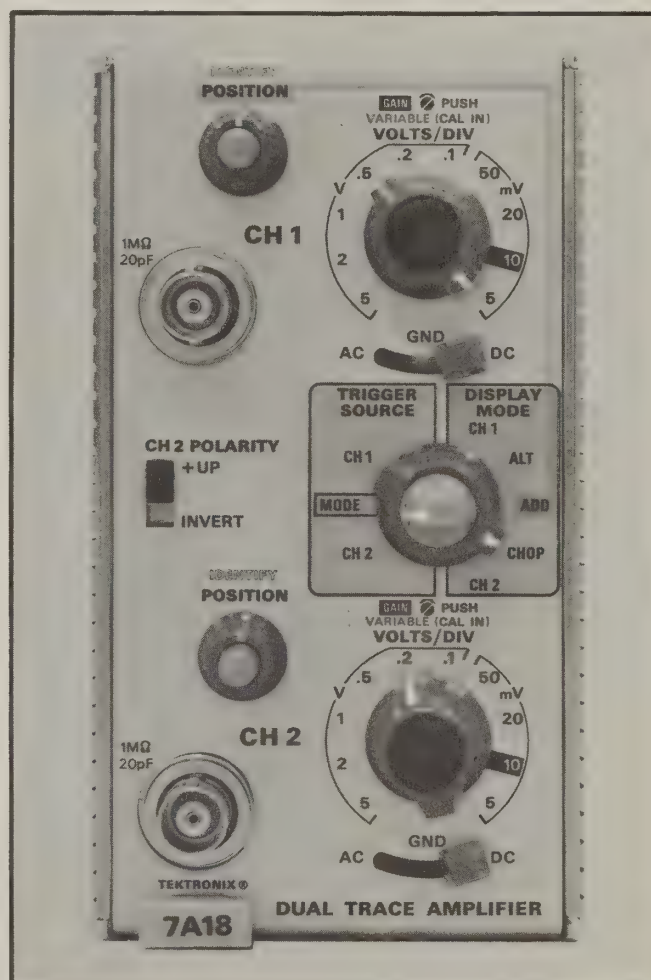


Fig. 2-1. Front-panel controls and connectors. (7A18 shown.)

	DC—Both AC and DC components of the signal are coupled to the amplifier input.
POSITION	Controls position of the trace. Positioning of the trace in the "ADD" Display Mode is controlled by CH 1 POSITION control only.
IDENTIFY (7A18 only)	Deflects trace about 0.2 division for trace identification. In instruments with readout, also replaces readout with the word "IDENTIFY".

VOLTS/DIV	Selects calibrated deflection factors from 5 mV/Div to 5 V/Div; ten steps in a 1-2-5 sequence.	CHOP display modes, the trigger signal is the algebraic sum of CH 1 and CH 2 trigger.
VARIABLE (VOLTS/DIV)	Provides continuously variable uncalibrated settings between calibrated steps. Extends the deflection factor range to 12.5 volts/division or more.	CH 2—Internal trigger signal obtained from signal applied to CH 2.
GAIN Adjustment	When the VARIABLE control is pushed in, it becomes a front-panel screw-driver adjustment for calibration of deflection factor.	CH 2 POLARITY Provides means of inverting the CH 2 display. +UP—A positive-going signal at the CH 2 input connector deflects the CRT display upward.
DISPLAY MODE	Selects one of the following modes of operation: CH 1—A single-trace display of the signal applied to Channel 1. ALT—A dual-trace display of the signal applied to both channels. The channels are alternately displayed, and switching occurs at the end of each time-base sweep. ADD—Algebraically adds the signals applied to the CH 1 and CH 2 input connectors, and the algebraic sum is displayed on the CRT. The CH 2 POLARITY switch allows the display to be CH 1 + CH 2 or CH 1 – CH 2. Position of the trace in this display mode is controlled by CH 1 POSITION control only. CHOP—A dual-trace display of the signals applied to both channels. The two channels time-share the sweep as determined by the indicator oscilloscope. CH 2—A single-trace display of the signal applied to CH 2.	INVERT—A positive-going signal at the CH 2 input connector deflects the CRT display downward.
TRIGGER SOURCE	Selects source of the trigger signal. The trigger signals provide internal triggering for the oscilloscope time-base units. CH 1—Internal triggering signal obtained from signal applied to CH 1. MODE—Internal trigger signal automatically follows DISPLAY MODE selection. In ADD or	

GENERAL OPERATING INFORMATION

Introduction

For single-trace operation, either of the two identical amplifier channels can be used independently by setting the DISPLAY MODE and TRIGGER SOURCE switches to CH 1 or CH 2 and connecting the signal to be observed to the appropriate input. In the discussions to follow, single-trace operations using CH 1 only apply equally to CH 2 only.

Signal Connections

In general, probes offer the most convenient means of connecting a signal to the input of the 7A18. A 10X attenuator probe offers a high input impedance and allows the circuit under test to perform very close to normal operating conditions.

The Tektronix P6053 probe, with its readout coding ring, was designed specifically for use with Tektronix 7A-series amplifier units equipped with readout. The readout coding ring on the probe connects to a circuit in the amplifier unit which automatically corrects the readout displayed on the CRT to the actual deflection factor at the tip of the probe being used. For probes to be used with amplifier units without readout, see the Tektronix, Inc. catalog.

Vertical Gain Check and Adjustment

To check the gain of either channel, set the VOLTS/DIV switch to 10 mV and connect 40 mV, 1 kHz signal from the oscilloscope calibrator to the input connector of the channel being checked. The vertical deflection should be exactly four divisions. If not, adjust the front-panel GAIN for exactly four divisions of deflection. The GAIN adjustment is engaged by pressing in the GAIN control knob and turning the knob with a narrow-blade screwdriver (see Front

Panel Controls and Connectors). Turn the knob clockwise, then counterclockwise, until the GAIN control is engaged. When the GAIN control is engaged, the vertical deflection will change as the knob is turned. Turn the GAIN control knob with the screwdriver until the deflection is set to exactly four divisions, then remove the screwdriver.

Input Coupling

The Channel 1 and Channel 2 coupling (AC-GND-DC) switches allow a choice of input coupling methods. The type of display desired and the applied signal will determine the coupling to use.

The DC coupling position must be used to display the DC component of the signal. It must also be used to display AC signals below about 30 hertz (ten hertz with a 10X probe) and square waves with low-frequency components as these signals are attenuated in the AC position.

In the AC coupling position, the DC component of the signal is blocked by a capacitor in the input circuit. The AC coupling position provides the best display of signals with a DC component much larger than the AC components. The precharge feature should be used with large DC inputs. To use this feature, first set the coupling to GND. Connect the probe to the circuit and wait about two seconds for the coupling capacitor to charge. Then set the coupling to AC.

The GND position provides a ground reference at the input of the amplifier without externally grounding the input connectors. However, the signals connected to the inputs are not grounded, and the same DC load is presented to the signal source.

VOLTS/DIV and VARIABLE Controls

The amount of vertical deflection produced by a signal is determined by the signal amplitude, the attenuation factor of the probe, the setting of the VOLTS/DIV switch, and the setting of the VARIABLE control. Calibration deflection factors indicated by the settings of the VOLTS/DIV switch apply only when the VARIABLE control is in the calibrated (CAL IN) position.

The VARIABLE control provides variable, uncalibrated settings between the calibrated steps of the VOLTS/DIV switch. With the VARIABLE control fully counterclockwise and the VOLTS/DIV set to 5 volts/div the uncalibrated vertical deflection factor is extended to at least 12.5 volts/division. By applying a calibrated voltage source to the input connector, any specific deflection factor can be set within the range of the VARIABLE control.

CH 2 POLARITY Switch

The CH 2 POLARITY switch may be used to invert the displayed waveform of the signal applied to the CH 2 input. This is particularly useful in added operation of the 7A18 when differential measurements are to be made. The CH 2 POLARITY switch has two positions, +UP and INVERT. In the +UP position, the displayed waveform will have the same polarity as the applied signal and a positive DC voltage will move the CRT trace up. In the INVERT position, a positive-going waveform at the CH 2 input will be displayed on the CRT in inverted form and a positive DC voltage will move the trace down.

DISPLAY MODE Switch

For single-trace operation, apply the signal either to the CH 1 input or the CH 2 input and set the DISPLAY MODE switch to the corresponding position: CH 1 or CH 2.

To display a signal in one channel independently when a signal is also applied to the other channel, simply select the desired channel by setting the DISPLAY MODE switch to the appropriate CH 1 or CH 2 position.

Alternate Mode. The ALT position of the DISPLAY MODE switch produces a display which alternates between channel 1 and channel 2 with each sweep on the CRT. Although the ALT mode can be used at all sweep rates, the CHOP mode provides a more satisfactory display at sweep rates below about 0.5 millisecond/division. At slow sweep rates alternate mode switching becomes visually perceptible.

Add Mode. The ADD position of the DISPLAY MODE switch can be used to display the sum or difference of two signals, for common-mode rejection to remove an undesired signal, or for DC offset (applying a DC voltage to one channel to offset the DC component of a signal on the other channel). The overall deflection factor in the ADD mode with both VOLTS/DIV switches set to the same position is the deflection factor indicated by either VOLTS/DIV switch. However, if the CH 1 and CH 2 VOLTS/DIV switches are set to different deflection factors, the resultant amplitude is difficult to determine from the CRT display. In this case, the voltage amplitude of the resultant display can be determined accurately only if the amplitude of the signal applied to one channel is known. In the ADD mode, positioning of the trace is controlled by the channel 1 POSITION control only.

Chop Mode. The CHOP position of the DISPLAY MODE switch produces a display which is electronically switched between channels at approximately a 500 kilohertz rate (controlled by mainframe). In general the CHOP mode provides the best display at sweep rates slower than

about 0.2 millisecond/division or whenever dual-trace, non-repetitive phenomena is to be displayed.

TRIGGER SOURCE Switch

CH 1. The CH 1 position of the TRIGGER SOURCE switch provides a trigger signal obtained from the signal applied to the CH 1 input connector. This provides a stable display of the signal applied to the CH 1 input connector.

CH 2. The CH 2 position of the TRIGGER SOURCE switch provides a trigger signal obtained from the signal applied to the CH 2 input connector. This provides a stable display of the signal applied to the CH 2 input connector.

MODE. In this position of the TRIGGER SOURCE switch, the trigger signal for the time-base unit is dependent on the setting of the DISPLAY MODE switch. The trigger source for each position of the DISPLAY MODE switch is as follows:

MODE	TRIGGER SIGNAL SOURCE
CH 1	Channel 1
CH 2	Channel 2
ADD	Algebraic sum of channel 1 and channel 2
CHOP	Algebraic sum of channel 1 and channel 2
ALT	Alternates between channel 1 and channel 2

Trace Identification (7A18 only)

When the IDENTIFY button is pressed, the trace is deflected about 0.2 division to identify the 7A18 trace. This feature is particularly useful when multiple traces are displayed. In instruments with readout, also replaces deflection factor readout with the word "IDENTIFY".

BASIC APPLICATIONS

General

The following information describes the procedures and techniques for making basic measurements with a 7A18 and the associated Tektronix oscilloscope and time-base. These applications are not described in detail since each application must be adapted to the requirements of the individual measurements. This instrument can also be used for many applications not described in this manual. Contact your local Tektronix Field Office or representative for assistance in making specific measurements with this instrument.

Peak-to-Peak Voltage Measurements (AC)

To make peak-to-peak voltage measurements, use the following procedure:

1. Apply the signal to either input connector.

2. Set the DISPLAY MODE and TRIGGER SOURCE switches to display the channel used.

3. Set the coupling switch to AC.

NOTE

For low-frequency signals below about 30 hertz use the DC position to prevent attenuation of the signal.

4. Set the VOLTS/DIV switch to display about five divisions of the waveform vertically.

5. Set the time-base Triggering controls for a stable display. Set the time-base unit to a sweep rate which displays several cycles of the waveform.

6. Turn the 7A18 POSITION control so the lower portion of the waveform coincides with one of the graticule lines below the center horizontal line, and the top of the waveform is within the viewing area. With the time-base Position control, move the display so one of the upper peaks lies near the center vertical line (see Fig. 2-2).

7. Measure the divisions of vertical deflection peak-to-peak. Check that the VARIABLE (VOLTS/DIV) control is in the CAL IN position.

NOTE

This technique can also be used to make measurements between two points on the waveform, rather than peak to peak.

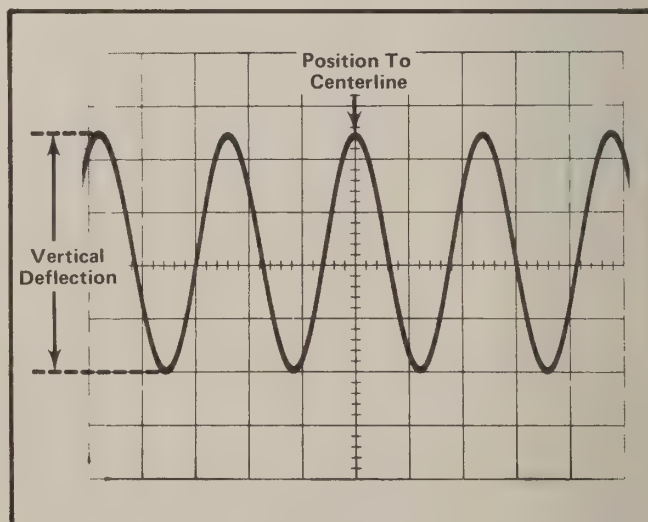


Fig. 2-2. Measuring the peak-to-peak voltage of a waveform.

8. Multiply the deflection measured in step 7 by the VOLTS/DIV switch setting. Include the attenuation factor of the probe if used.

EXAMPLE: Assume that the peak to peak vertical deflection is 4.5 divisions (see Fig. 2-2) using a 10X attenuator probe, and the VOLTS/DIV switch is set to 1 V.

$$\begin{array}{ccccccc} \text{Volts} & & \text{vertical} & & \text{VOLTS/DIV} & & \text{probe} \\ \text{Peak to Peak} & = & \text{deflection} & \times & \text{setting} & \times & \text{attenuation} \\ & & (\text{divisions}) & & & & \text{factor} \end{array}$$

Substituting the given values:

$$\text{Volts Peak-to-Peak} = 4.5 \times 1 \times 10$$

The peak-to-peak voltage is 45 volts.

Instantaneous Voltage Measurements (DC)

To measure the DC level at a given point on a waveform, proceed as follows:

1. Connect the signal to either input connector.
2. Set the DISPLAY MODE and TRIGGER SOURCE switches to display the channel used.
3. Set the VOLTS/DIV switch to display about five divisions of the waveform.
4. Set the coupling switch to GND and position the trace to the bottom graticule line or other reference line. If the voltage is negative with respect to ground, position the trace to the top graticule line. Do not move the POSITION control after this reference line has been established.

NOTE

To measure a voltage level with respect to a voltage other than ground, make the following changes to step 4. Set the coupling switch to DC and apply the reference voltage to the input connector. Then position the trace to the reference line.

5. Set the coupling switch to DC. The ground reference line can be checked at any time by switching to the GND position.

6. Set the time-base Triggering controls for a stable display. Set the time-base sweep rate for an optimum display of the waveform.

7. Measure the distance in divisions between the reference line and the point on the waveform at which the DC level is to be measured. For example, in Fig. 2-3 the measurement is between the reference line and point A.

8. Establish the polarity of the waveform. With the CH 2 POLARITY switch in the +UP position, any point above the reference line is positive.

9. Multiply the distance measured in step 7 by the VOLTS/DIV setting. Include the attenuation factor of the probe, if used.

EXAMPLE: Assume the vertical distance measured is 3.6 divisions (see Fig. 2-3) and the waveform is above the reference line using a 10X probe with a VOLTS/DIV setting of 0.5 V.

Using the formula:

$$\begin{array}{ccccccc} \text{Instantaneous} & & \text{vertical} & & \text{VOLTS/} & & \text{probe} \\ \text{Voltage} & = & \text{distance} & \times & \text{polarity} & \times & \text{attenuation} \\ & & (\text{divisions}) & & & & \text{factor} \end{array}$$

Substituting the given values:

$$\text{Instantaneous Voltage} = 3.6 \times +1 \times 0.5 \text{ V} \times 10$$

The instantaneous voltage is 18 volts.

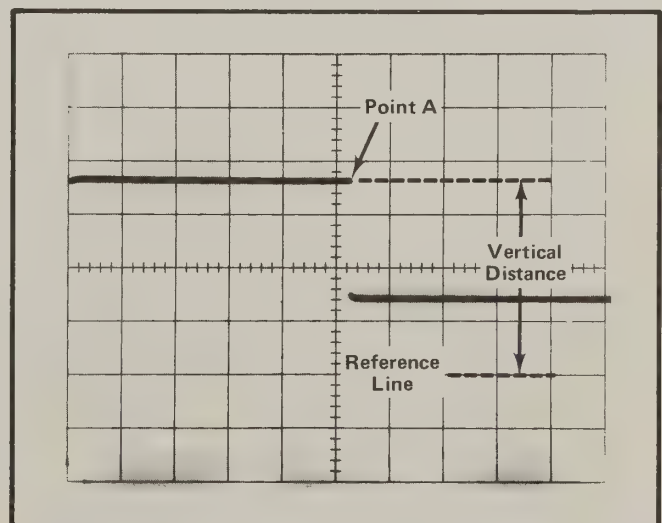


Fig. 2-3. Measuring instantaneous voltage with respect to some reference.

Comparison Measurements

In some applications it may be desirable to establish arbitrary units of measurement other than those indicated by the VOLTS/DIV switch. This is particularly useful when comparing unknown signals to a reference amplitude. One use for the comparison-measurement technique is to facilitate calibration of equipment where the desired amplitude does not produce an exact number of divisions of deflection. The adjustment will be easier and more accurate if arbitrary units of measurement are established so that the correct adjustment is indicated by an exact number of divisions of deflection. The following procedure describes how to establish arbitrary units of measure for comparison measurements.

To establish an arbitrary vertical deflection factor based upon a specific reference amplitude, proceed as follows:

1. Connect the reference signal to the input connector. Set the time-base unit sweep rate to display several cycles of the signal.

2. Set the VOLTS/DIV switch and the VARIABLE control to produce a display which is an exact number of vertical divisions in amplitude. Do not change the VARIABLE control after obtaining the desired deflection.

3. To establish an arbitrary vertical deflection factor so the amplitude of an unknown signal can be measured accurately at any setting of the VOLTS/DIV switch, the amplitude of the reference signal must be known. If it is not known, it can be measured before the VARIABLE VOLTS/DIV control is set in step 2.

4. Divide the amplitude of the reference signal (volts) by the product of the vertical deflection (divisions) established in step 2 and the setting of the VOLTS/DIV switch. This is the vertical conversion factor.

$$\text{Vertical Conversion Factor} = \frac{\text{reference signal amplitude (volts)}}{\text{vertical deflection (divisions)} \times \text{VOLTS/DIV switch setting}}$$

5. To measure the amplitude of an unknown signal, disconnect the reference signal and connect the unknown signal to the input connector. Set the VOLTS/DIV switch to a setting that provides sufficient vertical deflection to make an accurate measurement. Do not readjust the VARIABLE control.

6. Measure the vertical deflection in divisions and calculate the amplitude of the unknown signal using the following formula.

$$\text{Signal Amplitude} = \text{VOLTS/DIV setting} \times \text{vertical conversion factor} \times \text{vertical deflection (divisions)}$$

EXAMPLE: Assume a reference signal amplitude of 30 volts, a VOLTS/DIV setting of 5 V and the VARIABLE control adjusted to provide a vertical deflection of four divisions. Substituting these values in the vertical conversion factor formula (step 4):

$$\text{Vertical Conversion Factor} = \frac{30 \text{ V}}{4 \times 5 \text{ V}} = 1.5$$

Then with a VOLTS/DIV setting of 2 V, the peak-to-peak amplitude of an unknown signal which produces a vertical deflection of five divisions can be determined by using the signal amplitude formula (step 6):

$$\text{Signal Amplitude} = 2 \text{ V} \times 1.5 \times 5 = 15 \text{ volts}$$

Dual-Trace Phase Difference Measurements

Phase comparison between two signals of the same frequency can be made using the dual-trace feature of the 7A18. This method of phase difference measurement can be used up to the frequency limit of the oscilloscope system. To make the comparison, use the following procedure:

1. Set the CH 1 and CH 2 coupling switches to the same position, depending on the type of coupling desired.

2. Set the DISPLAY MODE to ALT or CHOP. In general, CHOP is more suitable for low frequencies and ALT is more suitable for high frequencies. Set the TRIGGER SOURCE to CH 1.

3. Connect the reference signal to the CH 1 input and the comparison signal to the CH 2 input. Use coaxial cables or probes which have similar time delay characteristics to connect the signals to the input connectors.

4. If the signals are of opposite polarity, set the CH 2 POLARITY switch to invert the channel 2 display. (Signals may be of opposite polarity due to 180° phase difference; if so, take this into account in the final calculation.)

5. Set the VOLTS/DIV switches and the VARIABLE controls of the two channels so the displays are equal and about five divisions in amplitude.

6. Set the time-base unit to a sweep rate which displays about one cycle of the waveforms. Set the Triggering controls for a stable display.

7. Center the waveforms on the graticule with the 7A18 POSITION controls.

8. Adjust the time-base Variable Time/Div control until one cycle of the reference signal occupies exactly eight horizontal divisions between the second and tenth vertical lines of the graticule (see Fig. 2-4). Each division of the graticule represents 45° of the cycle ($360^\circ \div 8 \text{ divisions} = 45^\circ/\text{division}$). The sweep rate can now be stated in terms of degrees as $45^\circ/\text{division}$.

9. Measure the horizontal difference between corresponding points on the waveform.

10. Multiply the measured distance (in divisions) by $45^\circ/\text{division}$ to obtain the exact amount of phase difference.

EXAMPLE: Assume a horizontal difference of 0.3 division with a sweep rate of $45^\circ/\text{division}$ as shown in Fig. 2-4.

Using the formula:

$$\text{Phase Difference} = \frac{\text{horizontal difference}}{\text{(divisions)}} \times \text{sweep rate} \text{ (degrees/division)}$$

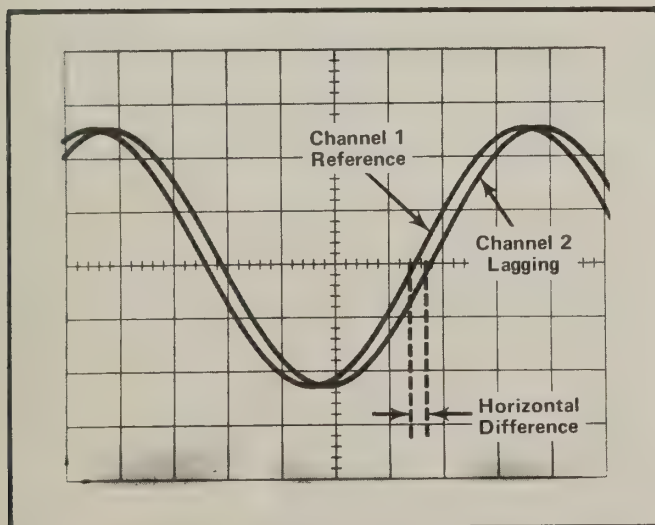


Fig. 2-4. Measuring phase difference between two signals.

Substituting the given values:

$$\text{Phase Difference} = 0.3 \times 45^\circ$$

The phase difference is 13.5° .

High Resolution Phase Measurements

More accurate dual-trace phase measurements can be made by increasing the sweep rate (without changing the Variable Time/Div control). One of the easiest ways to increase the sweep rate is with the time-base Magnifier switch. Set the Magnifier to X10 and determine the magnified sweep rate by dividing the sweep rate obtained previously by the amount of sweep magnification.

EXAMPLE: If the sweep rate is increased 10 times by the Magnifier, the magnified sweep rate is $45^\circ/\text{division} \div 10 = 4.5^\circ/\text{division}$. Fig. 2-5 shows the same signals as used in Fig. 2-4 but with the Magnifier set to X10. With a horizontal difference of 3 divisions, the phase difference is:

$$\text{Phase Difference} = \frac{\text{horizontal difference}}{\text{(divisions)}} \times \text{magnified sweep rate} \text{ (degrees/division)}$$

Substituting the given values:

$$\text{Phase Difference} = 3 \times 4.5^\circ$$

The phase difference is 13.5° .

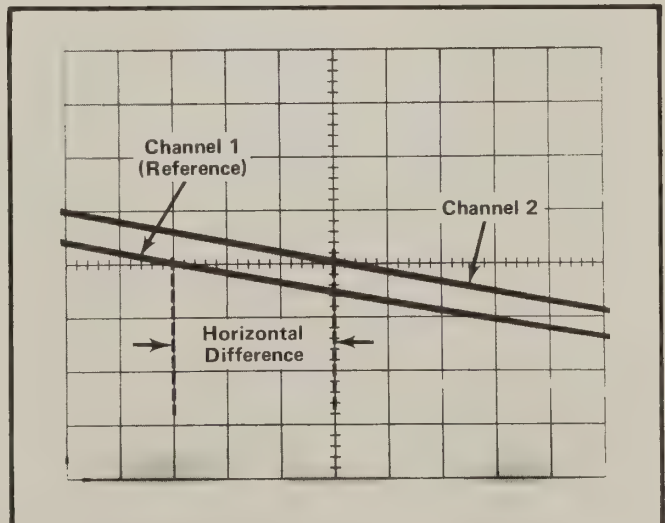


Fig. 2-5. High resolution phase measurement using time-base magnifier.

Common Mode Rejection

The ADD feature of the 7A18 can be used to display signals which contain undesirable components. These undesirable components can be eliminated through common-mode rejection. The procedure is as follows:

1. Set the DISPLAY MODE switch to ALT or CHOP and the TRIGGER SOURCE switch to MODE.

2. Connect the signal containing both the desired and undesired information to the CH 1 input connector.

3. Connect a signal similar to the unwanted portion of the CH 1 signal to the CH 2 input connector. For example, in Fig. 2-6 a line-frequency signal is connected to Channel 2 to cancel out the line-frequency component of the Channel 1 signal.

4. Set both coupling switches to the same setting, DC or AC, depending on the applied signal.

5. Set the VOLTS/DIV switches so the signals are about equal in amplitude.

6. Set the DISPLAY MODE switch to ADD. Set the CH 2 POLARITY switch to INVERT so the common-mode signals are of opposite polarity.

7. Adjust the Channel 2 VOLTS/DIV switch and VARIABLE control for maximum cancellation of the common-mode signal. The signal which remains should be only the desired portion of the Channel 1 signal.

EXAMPLE: An example of this mode of operation is shown in Fig. 2-6. The signal applied to Channel 1 contains unwanted line frequency components (Fig. 2-6A). A corresponding line frequency signal is connected to Channel 2 (Fig. 2-6B). Fig. 2-6C shows the desired portion of the signal as displayed when common-mode rejection is used.

The above procedure can also be used for examining a signal superimposed on some DC level when DC coupling is used. A DC voltage of the proper polarity applied to Channel 2 can be used to cancel out the DC portion of the signal applied to Channel 1.

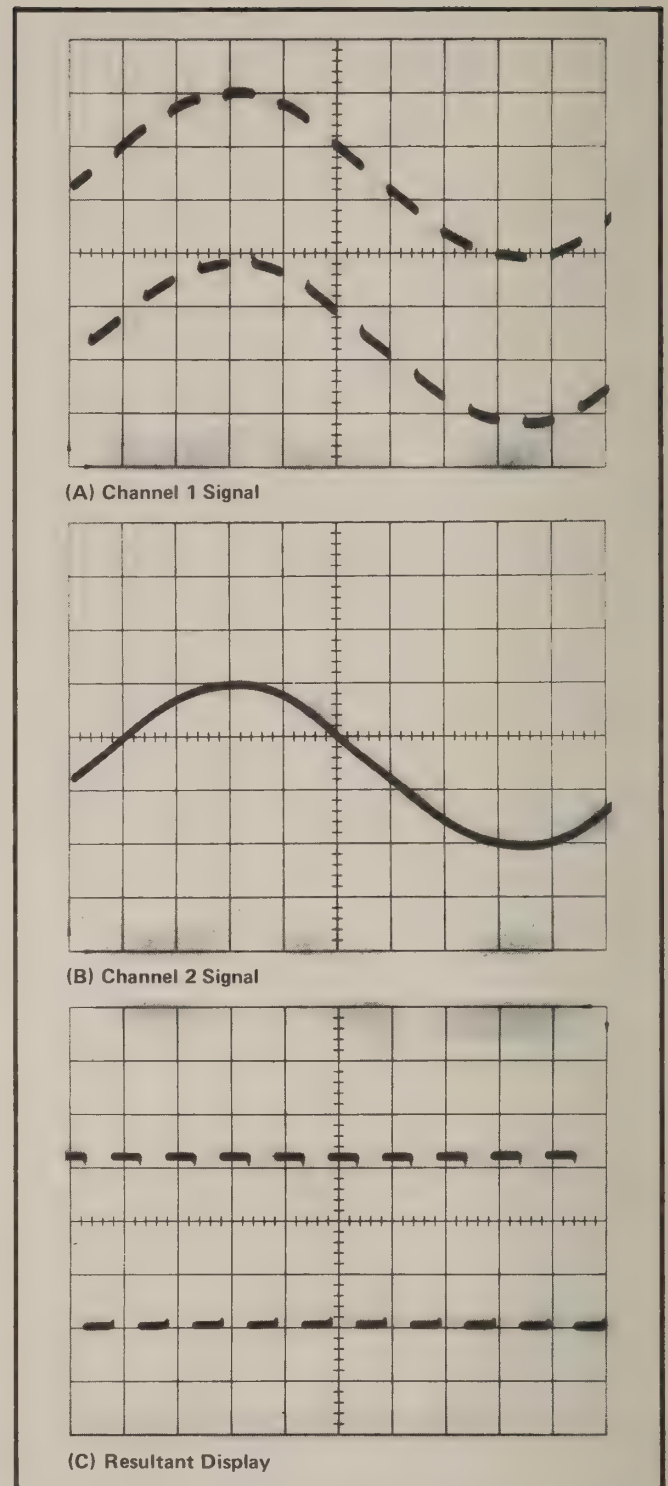


Fig. 2-6. Using the ADD mode for common-mode rejection. (A) Channel 1 signal contains desired information along with line-frequency component. (B) Channel 2 contains line frequency only. (C) Resultant CRT display using common-mode rejection.

SECTION 3

CIRCUIT DESCRIPTION

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section of the manual contains a description of the circuitry used in the 7A18 dual-trace amplifier. The description begins with a discussion of the instrument using the block diagram shown in the Diagrams section. Then, each circuit is described in detail using block diagrams to show the interconnections between stages in each major circuit and the relationship of the front-panel controls to the individual stages.

Complete schematics of each circuit are given in the Diagrams section. Refer to these schematics throughout the following circuit description for electrical values and relationship.

BLOCK DIAGRAM

The following discussion is provided to aid in understanding the overall concept of the 7A18 before the individual circuits are discussed in detail. Only the basic interconnections between the individual blocks are shown on the block diagram (see Diagrams section). Each block represents a major circuit within the instrument. The number on each block refers to the schematic on which the complete circuit is found.

The signal to be displayed on the CRT is applied to the input connector. The signal passes through the input coupling switch, where the appropriate coupling is selected, to the attenuators. The VOLTS/DIV switch selects the correct amount of attenuation and the signal is passed to the input amplifier.

The Channel 1 Input Amplifier circuit provides gain setting, variable gain control, and trace positioning. The Channel 2 Input Amplifier provides signal polarity inversion in addition to gain setting, variable gain control, and trace positioning. The outputs of these circuits are applied push-pull to the Signal and Trigger Channel Switches.

The Channel Switches select the proper signal and trigger as determined by the DISPLAY MODE and TRIGGER

SOURCE switches. The signal and trigger outputs are provided to the oscilloscope via the Interface Connector.

The Readout Encoding circuit (7A18 only) provides readout logic for the oscilloscope readout system. Data is supplied to the mainframe readout system identifying the polarity, deflection factor, the uncalibrated symbol (when the VARIABLE control is in the outward position), and the plug-in mode. When the IDENTIFY button is pressed, the trace is deflected about 0.3 division and the deflection factor readout is replaced by the word "IDENTIFY".

DETAILED CIRCUIT DESCRIPTION

ATTENUATOR

General

The Attenuator circuit determines the input coupling and the 7A18 deflection factor.

NOTE

The CH 1 and CH 2 Attenuator circuits are identical. To minimize duplication, only CH 1 is described in detail throughout this discussion.

AC-GND-DC Switch

Input signals connected to the input connector can be AC-coupled, DC-coupled, or internally disconnected. S100A is a cam-type switch; a contact-closure chart showing the operation is given on Diagram 1. The dots on this chart indicate when the associated contacts are in the position shown (open or closed). When the AC-GND-DC switch is in the DC position, the input signal is coupled directly to the Input Attenuator stage. In the AC position, the input signal passes through capacitor C10. This capacitor prevents the DC component of the signal from passing to the amplifier. The GND position opens the signal path and connects the input circuit of the amplifier to ground. This provides a ground reference without the need to disconnect the applied signal from the input connector. Resistor R102, connected across the AC-GND-DC switch, allows C10 to be precharged in the GND position so the trace remains on screen when switching to the AC position if the applied signal has a high DC level.

Input Attenuator

The effective overall deflection factor of the 7A18 is determined by the setting of the VOLTS/DIV switch, S100B. The basic deflection factor is five millivolts per division of CRT deflection. To increase the basic deflection factor to the values indicated on the front panel, precision attenuators are switched into the circuit. These attenuators are hybrid devices which contain the necessary resistances and capacitors. Each attenuator is replaceable as a unit. S100B is a cam-type switch and the dots on the contact-closure chart (see Diagram 1) indicate when the associated contacts are in the position shown (open or closed). In the 5 mV/Div position, input attenuation is not used; the input signal is connected directly to the input amplifier.

For switch positions above five millivolts, the attenuators are switched into the circuit singly or in pairs to produce the deflection factor indicated on the front panel. These attenuators are frequency-compensated voltage dividers. For DC and low-frequency signals, the attenuators are primarily resistance dividers and the voltage attenuation is determined by the resistance ratio in the circuit. The reactance of the capacitors in the circuit is so high at low frequencies that their effect is negligible. However, at higher frequencies, the reactance of the capacitors decreases and the attenuator becomes primarily a capacitance divider.

In addition to providing constant attenuation at all frequencies within the bandwidth of the instrument, the input attenuators are designed to maintain the same input RC characteristics (one megohm X 20 pF) for each setting of the VOLTS/DIV switch. Each attenuator contains an adjustable series capacitor to provide correct attenuation at high frequencies and an adjustable shunt capacitor to provide correct input capacitance.

CHANNEL 1 INPUT AMPLIFIER

General

The Channel 1 Input Amplifier converts the single-ended signal applied to the Channel 1 input connector to a differential (push-pull) output. Fig. 3-1 shows a detailed block diagram of the Channel 1 Input Amplifier. A schematic of this circuit is shown on Diagram 2 in the Diagrams section.

Input Source Follower

The Input Source Follower Q210A provides a high input impedance with a low impedance drive for the following stage. R210 limits the current drive to the gate of Q210A. Dual-diode CR210 provides circuit protection by limiting the voltage swing at the gate of Q210A to about $\pm$ (positive or negative) 15 volts. Q210B provides a constant current

source for Q210A. Q210A and Q210B are encapsulated in the same case so that Q210B temperature-compensates the circuit.

Paraphase Cascode Amplifier

Paraphase amplifier Q220-Q320, in conjunction with Q225-Q325, forms a cascode amplifier. Q220-Q320 convert the single-ended input signal to a differential output signal. Diodes CR220-CR221 hold the voltage level at the base of Q220 close to ground to limit the voltage swing to about ± 0.6 volt. Common-base connected Q225-Q325 provide isolation between the paraphase amplifier and the GAIN-VARIABLE controls. The gain of the Channel 1 Input Amplifier is set in this stage by front-panel GAIN control R237A with the CAL IN switch pressed in. When the CAL IN switch is in the outward (uncalibrated) position and turned fully counterclockwise to minimum resistance, the gain of the amplifier is reduced by a factor of at least 2.5. Adjustment 1 R321 varies the base level of Q320 to provide the same voltage levels at the collectors of Q225 and Q325. This prevents a zero-volt reference trace from changing position when varying the GAIN or VARIABLE controls.

Second Cascode Amplifier

The Second Cascode Amplifier stage provides a signal gain of approximately two. This stage includes the POSITION control and, in the 7A18 only, trace IDENTIFY circuitry. The emitters of common-base connected Q250-Q350 provide a low-impedance point for injection of the POSITION control and IDENTIFY switch currents. Position of the trace is determined by the setting of the POSITION control, R11. This control changes the current drive to Q250-Q350. Since the emitters are a very low-impedance point in the circuit, there is negligible voltage change at these points. However, the change in current from the POSITION control produces a resultant DC voltage difference at the collectors to change the position of the trace. Trace identification is accomplished by inserting resistor R357 from ground through CR357 to the junction of R11-R256. This results in a slight increase in the emitter current of Q250 to cause the trace to move. This aids in identifying the channel 1 trace when multiple traces are displayed.

The network C246-C345-C245-R246-R345-R245 provides high frequency compensation. R245-C245 in this network provide high-frequency response adjustment for this stage.

Emitter Follower

Emitter Follower stage Q260-Q360 provides a low output impedance to drive the Signal and Trigger Channel Switches, U270-U470. This stage also provides isolation between the Second Cascode Amplifier and U270-U470.

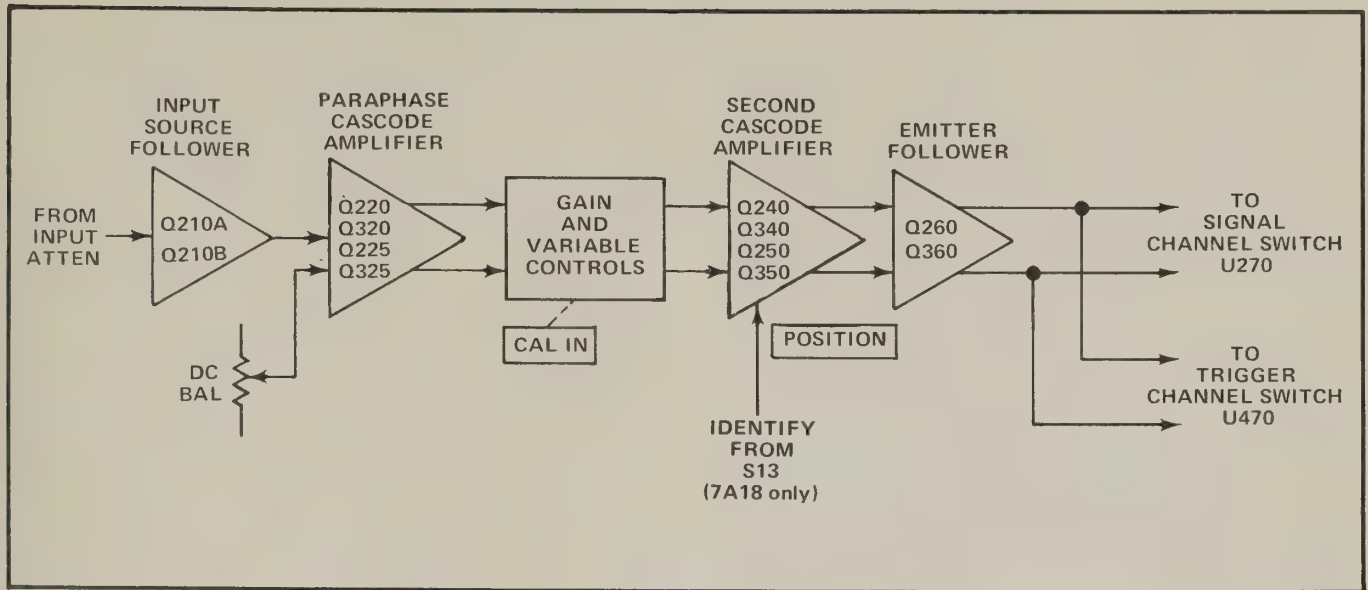


Fig. 3-1. Channel 1 Input Amplifier detailed block diagram.

CHANNEL 2 INPUT AMPLIFIER

General

The Channel 2 Input Amplifier circuit is basically the same as the Channel 1 Input Amplifier circuit. Only the differences between the two circuits are described here. Portions of this circuit not described in the following description operate in the same manner as for the Channel 1 Input Amplifier circuit (corresponding circuit numbers assigned in the 400 – 599 range). Fig. 3-2 shows a detailed block diagram of the Channel 2 Input Amplifier circuit. A schematic of this circuit is shown on Diagram 3 in the Diagrams section.

Paraphase Cascode Amplifier

The Paraphase Cascode Amplifier for Channel 2 consists of Q420, Q520, Q425, Q525, Q426, and Q526. In addition to the functions described under Channel 1 Input Amplifier, the Channel 2 Paraphase Cascode Amplifier stage provides a means of inverting the displayed signal. With the CH 2 POLARITY switch set to +UP, Q425 and Q525 are biased on and the signal is passed to the Second Cascode Amplifier stage as for the Channel 1 Input Amplifier. With the CH 2 POLARITY switch set to INVERT, Q425 and Q525 are biased off and Q426-Q526 are turned on to provide signal inversion.

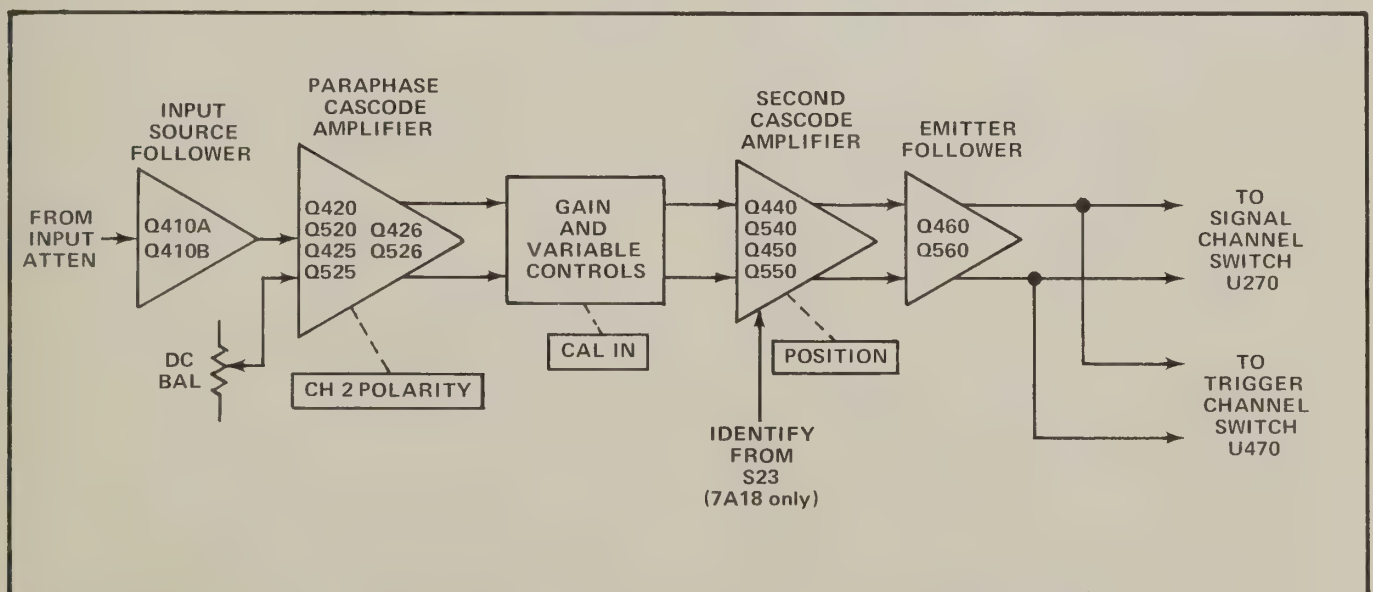


Fig. 3-2. Channel 2 Input Amplifier detailed block diagram.

Second Cascode Amplifier

The Second Cascode Amplifier for Channel 2 consists of Q440, Q540, Q450, and Q550. Position of the trace is set by the POSITION control, R21 or by network R455-R555 as determined by the DISPLAY MODE switch. In any DISPLAY MODE switch position other than ADD, +50 volts is applied to the center arm of the POSITION control through R32. The POSITION control varies the current drive to the emitters of Q450-Q550. Since the emitters are a very low-impedance point in the circuit, there is negligible voltage change at these points. However, the change in current from the POSITION control produces a resultant DC voltage difference at the collectors to change the position of the trace. When the DISPLAY MODE switch is in the ADD position, +50 volts is applied to the junction of resistors R455-R555 through R32 to balance the current drive to the emitters of Q450-Q550. This results in a fixed zero volts (approximately) difference between the collectors. Since +50 volts is not applied to the POSITION control in the ADD position of the DISPLAY MODE switch, the control setting has no effect on the circuit operation.

CHANNEL SWITCHES

General

The Channel Switches circuit provides Signal and Trigger outputs to the oscilloscope via the Interface Connector as determined by the DISPLAY MODE and TRIGGER SOURCE switches. A schematic of this circuit is given on Diagram 4 in the Diagrams section.

Signal Channel Switch

The Signal Channel Switch stage consists of integrated circuit U270 and its external components. This stage selects one, or mixes two input analog signals in response to inputs from the DISPLAY MODE switch. The Signal Channel Switch stage determines which input (CH 1 or CH 2) provides the signal to the oscilloscope as controlled by the DISPLAY MODE switch setting. Resistors R276-R277 and R376-R377 set the current gain for each channel. Networks C274-R274-C275-R275 and C374-R374-C375-R375 provide high-frequency compensation for each channel. C275 and C375 in these networks are high-frequency compensation adjustments.

Fig. 3-3 shows the U270 input combinations for each position of the DISPLAY MODE switch. When the level at pin 14 is LO the output of U270 is determined by the level at pin 4. With the level at pin 14 HI and the level at pin 4 LO, the signals from both channel 1 and channel 2 are passed to the Signal Output stage. This condition occurs only when the DISPLAY MODE switch is set to ADD. In this operating mode the signal output is the algebraic sum of channel 1 and channel 2 signals and the resultant signal determines the mainframe deflection.

DISPLAY MODE SELECTED	U270	
	Pin 4	Pin 14
CH 1	LO	LO
ALT	**	LO
ADD	LO	HI
CHOP	*	LO
CH 2	HI	LO

*Level is switched between the HI-level and LO-level at an approximate 0.5 megahertz rate.

**Level is switched between the HI-level and LO-level at a rate determined by the setting of the time-base unit sweep rate.

Fig. 3-3. U270 input combinations for DISPLAY MODE selection.

Trigger Channel Switching

The Trigger Channel Switch U470 is identical to the Signal Channel Switch. This stage determines which input (CH 1 or CH 2) provides the trigger signal for internal triggering of the time-base unit. The selection of the trigger signal is controlled by inputs from the TRIGGER SOURCE switch. Resistors R476-R477 and R576-R577 set the current gain for each channel. Networks C474-R474-C475-R475 and C574-R574-C575-R575 provide high-frequency compensation for each channel.

An input/output table for this stage is shown in Fig. 3-4. When the level at pin 14 is LO, the output of U470 is determined by the level at pin 4. With the level at pin 14 HI and the level at pin 4 LO, the channel 1 and channel 2 triggers are added algebraically.

Signal and Trigger Output

The Signal Output stage, Q280-Q380, and the Trigger Output stage, Q480-Q580, are similar. Each stage consists of a pair of common-base connected transistors which provide the DC level shifting necessary to drive the mainframe circuits.

DISPLAY MODE AND TRIGGER SWITCHING

General

The Display Mode and Trigger Switching circuit determines which input signal (Channel 1 or Channel 2) provides the Signal and Trigger outputs to the mainframe as selected by the DISPLAY MODE and TRIGGER SOURCE switches. This circuit also provides plug-in mode information to the mainframe chop blanking circuit, and readout control information for proper CRT display.

DISPLAY MODE Switch

The DISPLAY MODE switch provides logic level outputs to the Signal Channel Switch stage (U270, Channel Switches diagram 4). A table of the outputs for each position of the DISPLAY MODE switch is shown in Fig. 3-3.

TRIGGER SOURCE Switch

The TRIGGER SOURCE switch provides logic level outputs to the Trigger Channel Switch (U470, Channel Switches diagram 4). A table of the outputs for each switch position is shown in Fig. 3-4.

INPUT		OUTPUT		
Display Mode Switch	Trigger Source Switch	U470 Pins 4 14		Trigger Signal Source
CH 1	CH 1	HI	LO	CH 1
	MODE	HI	LO	CH 1
	CH 2	LO	LO	CH 2
ALT	CH 1	HI	LO	CH 1
	MODE	HI-LO	LO	Alternates between CH 1 and CH 2
	CH 2	LO	LO	CH 2
ADD	CH 1	HI	LO	CH 1
	MODE	LO	HI	CH 1 and CH 2 added
	CH 2	LO	LO	CH 2
CHOP	CH 1	HI	LO	CH 1
	MODE	LO	HI	CH 1 and CH 2 added
	CH 2	LO	LO	CH 2
CH 2	CH 1	HI	LO	CH 1
	MODE	LO	LO	CH 2
	CH 2	LO	LO	CH 2

Fig. 3-4. Input/Output combinations for DISPLAY MODE and TRIGGER SOURCE switch selections.

CONNECTORS AND READOUT

General

The Connectors and Readout circuit consists of the power supply and signal distribution from the Interface Connector and the Readout Encoding circuit. A schematic of this circuit is shown on Diagram 6 in the Diagrams section.

Connectors

All the connections made to the mainframe by the 7A18 are shown on the Connectors portion of Diagram 6. Also shown are the power supply decoupling components.

Readout Encoding (7A18 only)

The Readout Encoding circuit consists of switching resistors and probe sensing stage Q620. This circuit encodes the Channel 1 and 2, Row and Column output lines for readout of deflection factor, uncalibrated deflection factor (VARIABLE) information, and signal inversion (channel 2 only). Data is encoded on these output lines by switching resistors between them and the time-slot input lines, or by adding current through Q620.

R647-CR647 are switched between time-slot three (TS-3) and Column output line when the CAL IN switch is in the uncal position. This results in the symbol > (greater than) being displayed preceding the deflection factor readout. R648 (Channel 2 only) is switched between TS-2 and the Column output line when the CH 2 POLARITY switch is in the INVERT position. This results in the symbol ↓ (inverted) being displayed preceding the deflection factor readout.

Switching resistors are used to indicate the setting of the VOLTS/DIV switch to the mainframe readout system. The VOLTS/DIV switch is a cam-type switch. The dots on the contact-closure chart (see Diagram 6) indicate when the associated contacts are closed. R633, R634, and R635 select the number 1, 2, or 5 depending on the resistor combination that is switched in. R637 selects the m (milli-) prefix and R639 selects the symbol V (volts) in the 5 mV through .5 V (500 mV) positions of the VOLTS/DIV switch. R638 selects the symbol V in the 1, 2, and 5 V positions. R630, R631, and the output of the probe sensing stage (Q620) select the decimal point (number of zeroes) again depending on the resistor combination switched in by the VOLTS/DIV switch.

Probe sensing stage Q620 identifies the attenuation factor of the probe connected to the input connector by sensing the amount of current flowing from the current sink through the probe coding resistance. The output of this circuit corrects the mainframe readout system to include the probe attenuation factor. The third contact of the input connector provides the input to the probe sensing stage from the probe coding resistance (coded probes only; see Operating Instructions). The third contact is also used for the IDENTIFY input. The coding resistor forms a voltage divider with R621 through CR621 to the -15 V supply. The resultant voltage sets the bias on Q620 and determines, along with emitter resistor R622, the collector current. When the -15 volt time-slot pulse is applied to Interface Connector B33, Q620 is interrogated and its collector current is added to the column current output through Interface Connector A37.

Circuit Description—7A18/7A18N

With a 1X probe (or no probe) connected to the input connector, Q620 is turned off. The deflection factor readout is determined by the VOLTS/DIV switch position. With a 10X probe connected, the bias on Q620 will allow 100 microamperes of collector current to flow. This increases the deflection factor readout by a factor of 10.

The IDENTIFY button (S13 or S23 on Diagram 1) does two things when pressed:

1. It causes the trace representing the appropriate channel of the 7A18 to move about 0.3 division (see the discussion on the Channel 1 or Channel 2 Input Amplifier).

2. Forward biases CR621 and Q620 to result in a sufficient amount of collector current which, when added to the column current output, replaces the deflection factor readout with the word "IDENTIFY".

These two actions aid in identifying the 7A18 trace when multiple traces are displayed. When the IDENTIFY button is released, the deflection factor readout and trace position are restored.

For further information on the operation of the readout system, see the oscilloscope instruction manual.

SECTION 4

MAINTENANCE

Change information, if any, affecting this section will be found at the rear of this manual.

Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance, and troubleshooting of the 7A18.

Further maintenance information relating to component color codes and soldering techniques can be found in the instruction manuals for the 7000-series oscilloscopes.

PREVENTIVE MAINTENANCE

General

Preventive maintenance, consisting of cleaning, visual inspection, lubrication, etc., performed on a regular basis, will improve the reliability of this instrument. Periodic checks on the semiconductor devices used in the unit are not recommended as a preventive maintenance measure. See semiconductor-checking information given under Troubleshooting.

Cleaning

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics in this instrument. Avoid chemicals containing benzene, toluene, xylene, acetone, or similar solvents.

Front Panel. Loose dust may be removed with a soft cloth or a dry brush. Water and mild detergent may be used; however, abrasive cleaners should not be used.

Interior. Cleaning the interior of the unit should precede calibration, since the cleaning process could alter the settings of the calibration adjustments. Use low-velocity compressed air to blow off the accumulated dust. Hardened dirt can be removed with a soft, dry brush, cotton-tipped swab, or cloth dampened with a mild detergent and water solution.

Lubrication

Use a cleaning-type lubricant on shaft bushings, interconnecting plug contacts, and switch contacts. Lubricate switch detents with a heavier grease. A lubrication kit containing the necessary lubricating materials and instructions is available through any Tektronix Field Office. Order Tektronix Part Number 003-0342-00.

Recalibration

To ensure accurate measurements, the 7A18 should be checked after each 1000 hours of operation or every six months if used infrequently. A complete performance check procedure is given in Part I for Section 5.

The performance check procedure can be helpful in isolating major troubles in the unit. Moreover, minor troubles not apparent during regular operation may be revealed and corrected.

TROUBLESHOOTING

General

The following is provided to augment information contained in other sections of this manual when troubleshooting the 7A18. The schematic diagrams, Circuit Description, and Calibration sections should be used to full advantage. The Circuit Description section gives detailed information on circuit behavior and output requirements.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 7. The circuit number and electrical value of each component in this instrument are shown on the diagrams. Important voltages are also shown.

Circuit Board. The circuit board used in the 7A18 is outlined on the schematic diagrams, and a photograph of the board is shown on the back of Diagram 1. Each board-mounted electrical component is identified on the photograph by its circuit number.

Component and Wiring Color Code. Colored stripes or dots on resistors and capacitors signify electrical values, tolerances, etc., according to the EIA standard color code. Components not color coded usually have the value printed on the body.

The insulated wires used for interconnection in the 7A18 are color coded to facilitate tracing a wire from one point to another in the unit.

Semiconductor Lead Configuration. Fig. 4-1 shows the lead configuration of the semiconductor devices used in this instrument.

Troubleshooting Equipment

The following equipment is useful for troubleshooting the 7A18.

1. Semiconductor Tester—Some means of testing the transistors, diodes, and FET's used in this instrument is helpful. A transistor-curve tracer such as the Tektronix Type 576 will give the most complete information.

2. DC Voltmeter and Ohmmeter—A voltmeter for checking voltages within the circuit and an ohmmeter for checking resistors and diodes are required.

3. Test Oscilloscope—A test oscilloscope is required to view waveforms at different points in the circuit.

A Tektronix 7000-series Oscilloscope equipped with a readout system, 7D13 Digital Multimeter unit, 7B-series Time-Base unit, and a 7A-series Amplifier unit with a 10X probe will meet the needs for items 2 and 3.

Troubleshooting Procedure

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting.

1. Check Control Setting. An incorrect setting of the 7A18 controls can indicate a trouble that does not exist. If there is any question about the correct function or operation of a control or front-panel connector, see the Operating Instructions section.

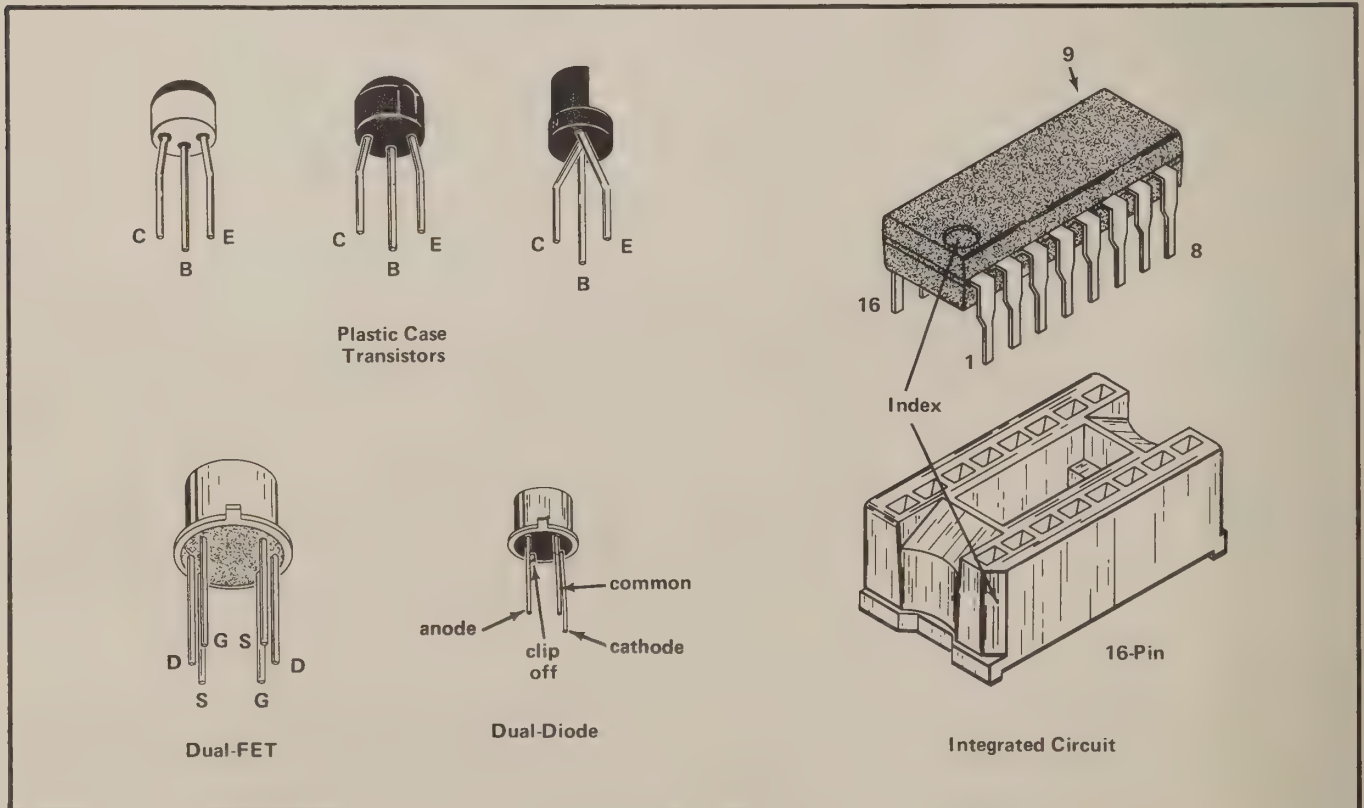


Fig. 4-1. Electrode configuration for semiconductors used in this instrument.

2. Check Associated Equipment. Before proceeding with troubleshooting of the 7A18, check that the equipment used with this instrument is operating correctly. If possible, substitute an amplifier unit known to be operating correctly into the indicator unit and see if the problem persists. Check that the inputs are properly connected and that the interconnecting cables are not defective.

3. Visual Check. Visually check the portion of the instrument in which the trouble is suspected. Many troubles can be located by visual indications, such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

4. Check Instrument Performance. Check the calibration of the unit, or the affected circuit by performing Part I — Performance Check of Section 5. The apparent trouble may only be a result of misadjustment and may be corrected by calibration. Complete calibration instructions are given in Part II of Section 5.

5. Check Voltages and Waveforms. Often the defective component or stage can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are given on the diagrams; however, these are not absolute and may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the instructions in the Diagrams section.

6. Check Individual Components. The following methods are provided for checking the individual components in the 7A18. Components which are soldered in place are best checked by disconnecting one end to isolate the measurement from the effects of surrounding circuitry.

A. TRANSISTORS AND INTEGRATED CIRCUITS. The best check of transistor and integrated circuit operation is actual performance under operating conditions. If a transistor or integrated circuit is suspected of being defective, it can best be checked by substituting a component known to be good; however, be sure that circuit conditions are not such that a replacement might also be damaged. If substitute transistors are not available, use a dynamic tester (such as Tektronix Type 576). Static-type testers may be used, but since they do not check operation under simulated operating conditions some defects may go unnoticed. Fig. 4-1 shows base pin and socket arrangements of semiconductor devices. Be sure the power is off before attempting to remove or replace any transistor or integrated circuit.

Integrated circuits can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of the circuit description is essential to troubleshooting circuits using integrated circuits. Use care when checking voltages and waveforms around the integrated circuits so that adjacent leads are not shorted together. An integrated-circuit test clip provides a convenient means of clipping a test probe to the 14- and 16-pin integrated circuits. This device also doubles as an integrated-circuit extraction tool.

B. DIODES. A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high in one direction and very low when the leads are reversed.

CAUTION

Do not use an ohmmeter scale that has a high internal current. High currents may damage the diodes.

C. RESISTORS. Check resistors with an ohmmeter. Resistor tolerance is given in the Electrical Parts List. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

D. CAPACITORS. A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter on the highest scale. Use an ohmmeter which will not exceed the voltage rating of the capacitor. The resistance reading should be high after initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter, or by checking whether the capacitor passes AC signals.

7. Repair and Readjust the Circuit. Special techniques required to replace components in this unit are given under Component Replacement. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced. Recalibration of the affected circuit may be necessary.

REPLACEMENT PARTS

Standard Parts

All electrical and mechanical part replacements for the 7A18 can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, check the parts lists for value, tolerance, rating, and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of the component may affect its performance in the instrument. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect the instrument performance.

Special Parts

Some parts are manufactured or selected by Tektronix to satisfy particular requirements, or are manufactured for Tektronix to our specifications. These special parts are indicated in the parts list by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix. Order all special parts directly from your local Tektronix Field Office or representative.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., refer to the Parts Ordering Information and Special Notes and Symbols on the page immediately preceding the Electrical Parts List section. Include the following information:

1. Instrument type (7A18)
2. Instrument Serial Number
3. A description of the part (if electrical, include the circuit number)
4. Tektronix Part Number

Soldering Techniques

Attenuator Circuit Boards. The Attenuator circuit boards are made from polyphenylene oxide because of its excellent electrical characteristics. Use more than normal care when cleaning or soldering this material. The following rules should be observed when removing or replacing parts:

1. Use a very small soldering iron (not over 15 watts).
2. Do not apply more heat, or apply heat for a longer time, than is absolutely necessary.
3. Use a vacuum-type desoldering tool to remove the excess solder from the circuit board.
4. Do not apply any solvent containing ketones, esters, or halogenated hydrocarbons.
5. To clean, use only water-soluble detergents, ethyl, methyl, or isopropyl alcohol.

COMPONENT REPLACEMENT**General**

The exploded-view drawing associated with the Mechanical Parts List may be helpful when disassembling or reassembling individual components or sub-assemblies.

Circuit Board Removal

In general, the circuit boards used in the 7A18 need never be removed unless they must be replaced. Electrical connections to the boards are made by soldered connections. If it is necessary to replace a circuit board assembly, use the following procedures.

A. READOUT CIRCUIT BOARD REMOVAL (7A18 only)

1. Disconnect the wires connected to the outside of the board.
2. Remove the seven screws holding the board to the mounting surface.
3. Disconnect the wires connected to the inside of the board.
4. Remove the board from the unit.
5. To replace the board, reverse the order of removal.

B. ATTENUATOR CIRCUIT BOARD REMOVAL

1. Remove the readout board as outlined in the previous procedure.
2. Disconnect the resistor/capacitor connected to the rear of the board.
3. Loosen the front set screw on the VARIABLE/GAIN control shaft coupling (use a 0.050-inch hex-key wrench).
4. Remove the red VARIABLE control knob and rod from the control shaft.
5. Remove the remaining front-panel knobs using a 1/16-inch hex-key wrench.
6. Remove the front panel from the instrument.
7. Remove the attenuator shields.
8. Disconnect the wires and resistor from the input BNC connector.
9. Remove the input BNC connector.

10. Remove the POSITION control using a 5/16-inch nut driver.

11. Remove the attenuator board with cam switch from the instrument.

12. To replace the board, reverse the order of removal.

C. AMPLIFIER CIRCUIT BOARD REMOVAL

1. Remove the Readout circuit boards as given previously.

2. Remove the plastic plug-in guide from the rear of the instrument.

3. Disconnect the wires connected to the board from the front-panel controls.

4. Loosen the front hex-socket screw in the front coupling of the VARIABLE control shaft using a 0.050-inch hex-key wrench. Pull the VARIABLE knob and shaft from the front of the instrument.

5. Loosen the front hex-socket screw in the coupling between the DISPLAY MODE and TRIGGER SOURCE switch sections. Pull the TRIGGER SOURCE knob and long shaft from the front of the instrument.

6. Loosen the front hex-socket screw in the coupling of the DISPLAY MODE switch shaft using a 5/16-inch hex-key wrench. Pull the DISPLAY MODE knob and long shaft from the front of the instrument.

7. Disconnect the resistor-capacitor combinations connected to the ceramic strips at the front of the board.

8. Remove the screws and nuts securing the board to the chassis or other mounting surface.

9. Remove the board from the instrument.

10. To replace, reverse the order of removal.

Switch Replacement

Several types of switches are used in the 7A18. The following special maintenance information is provided for the cam-type switches and rotary switches.

CAUTION

Repair of cam-type switches should be undertaken only by experienced maintenance personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance in maintenance of the cam-type switches, contact your local Tektronix Field Office or representative.

A. CAM-TYPE SWITCHES

NOTE

A cam-type switch repair kit including necessary tools, instructions, and replacement contacts is available from Tektronix, Inc. Order Tektronix Part No. 040-0541-00.

The cam-type switches consist of a rotating cam, which is turned by the front-panel knobs, and a set of contacts mounted on an adjacent circuit board. These switch contacts are actuated by lobes on the cam. The VOLTS/DIV and AC-GND-DC (coupling) cam-type switches can be disassembled for inspection, cleaning, repair, or replacement as follows:

1. Remove the Readout board and the Attenuator board/switch assembly as described previously. The front switch section on the Attenuator board is the AC-GND-DC switch and the rear switch section is the VOLTS/DIV switch. The switches are now open for inspection or cleaning.

2. To completely remove the switches from the board, remove the two screws and four hexagonal posts which hold the cam-type switch to the circuit board.

3. To remove the cam from the front support block, remove the retaining ring from the shaft on the front of the switch and slide the cam out of the support block. Be careful not to lose the small detent roller.

4. To replace defective switch contacts, follow the instructions given in the switch repair kit.

5. To re-install the switch assembly, reverse the above procedure.

B. ROTARY SWITCHES

Single wafers on the DISPLAY MODE and TRIGGER SOURCE switches are not normally replaced. If any part of these switches is defective, the entire switch assembly should be replaced. A new switch can be ordered through your Tektronix Field Office.

CAUTION

When disconnecting or connecting leads to a wafer-type rotary switch, do not let solder flow around and beyond the rivet on the switch terminal. Excessive solder can destroy the spring tension of the contact.

Transistor and Integrated Circuit Replacement

Transistors and IC's should not be replaced unless they are actually defective. If removed from their sockets during routine maintenance, return them to their original sockets. Special care must be given to integrated circuit leads, because they can easily be damaged in removal from sockets. Unnecessary replacement or switching of components may affect the calibration of the instrument. When a transistor is replaced, check the operation of that part of the instrument that may be affected.

Recalibration After Repair

After any electrical component has been replaced, the calibration of that particular circuit should be checked, as well as the calibration of other closely related circuits. The Performance Check instructions given in Part I of Section 5 provide a quick and convenient means of checking the instrument operation. The Calibration Procedure in Part II of Section 5 can then be used to adjust the operation to meet the Performance Requirements listed in Section 1.

SECTION 5

CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Recalibration Interval

To assure instrument accuracy, check the calibration of the 7A18 every 1000 hours of operation, or every six months if used infrequently. Before complete calibration, thoroughly clean and inspect this instrument as outlined in the Maintenance section.

Tektronix Field Service

Tektronix, Inc. provides complete instrument repair and recalibration at local Field Service Centers and the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

Using This Procedure

General. This section provides several features to facilitate checking or adjusting the 7A18. These are:

Index. To aid in locating a step in the Performance Check or Adjustment procedure, an index is given preceding Part I — Performance Check and Part II — Adjustment procedure.

Performance Check. The performance of this instrument can be checked without removing the side shields or making internal adjustments by performing only Part I — Performance Check. This procedure checks the instrument against the tolerances listed in the Performance Requirement column of Section 1. In addition, a cross-reference is provided to the step in Part II — Adjustment which will return the instrument to correct calibration. In most cases, the adjustment step can be performed without changing control settings or equipment connections.

Adjustment Procedure. To return this instrument to correct calibration with the minimum number of steps, perform only Part II — Adjustment. The Adjustment procedure gives the recommended calibration procedure for all circuits in this instrument.

Complete Performance Check/Adjustment. To completely check and adjust all parts of this instrument, perform both Parts I and II. Start the complete procedure by performing the Adjustment procedure and follow this with the Performance Check. This method will assure that the

instrument is both correctly adjusted and performing within all Performance Requirements as given in Section 1.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or its equivalent, is required for complete calibration of the 7A18. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed here may be somewhat less precise than the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within the listed specifications.

The Performance Check and Adjustment procedures are based on this recommended equipment. If other equipment is substituted, control settings or calibration setup may need to be altered to meet the requirements of the equipment used. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

Calibration Equipment Alternatives

All of the test equipment is required to completely check and adjust this instrument. However, some of the items used only for the Performance Check can be deleted without compromising the instrument's measurement capabilities. For example, the low-frequency constant-amplitude signal generator is used only in the Performance Check and may be deleted if the user does not desire to check the lower frequency response or trigger source operation. Equipment used only for the Performance Check procedure is indicated by note 1; items required only for the Adjustment procedure are indicated by note 2.

Test Equipment

1. 7000-series oscilloscope, referred to as the Indicator Oscilloscope in this procedure. Tektronix 7403 recommended.

2. Time-Base plug-in unit, Tektronix 7B50.

3. Standard Amplitude Calibrator. Output signal, one-kilohertz square wave; output amplitude, 20 millivolts to 20 volts; amplitude accuracy, within 0.25%. Tektronix calibration fixture 067-0502-01 recommended.

4. Medium-frequency constant-amplitude sine-wave generator.¹ Frequency, variable from 50 to 75 megahertz; reference frequency, 50 kilohertz; output amplitude, variable from 50 millivolts to 200 millivolts into 50 ohms; amplitude accuracy, output amplitude constant within 3% at 50 kilohertz and from 50 to 75 megahertz. For example, Tektronix Type 191 Constant Amplitude Signal Generator.

5. Low-frequency constant-amplitude signal generator.¹ Frequency range, two hertz to 10 kilohertz; output amplitude, variable from 10 millivolts to 400 millivolts peak to peak. For example, General Radio 1310-B Oscillator (use General Radio Type 274 QBJ Adapter to provide BNC output).

6. Square-wave generator.² Must have the following output capabilities (may be obtained from separate generators): 12 volts amplitude into 50 ohms at one kilohertz with a risetime of 12 nanoseconds or less; 500 millivolts into 50 ohms at 100 kilohertz with a risetime of one nanosecond or less. Tektronix Type 106 Square-Wave Generator recommended (meets both output requirements).

7. Plug-in extender.² Tektronix Part Number 067-0589-00.

Accessories

8. 18-inch cable.¹ Impedance, 50 ohms; type, RG-58/U; connectors, BNC. Tektronix Part No. 012-0076-00.

9. 42-inch cable. Impedance, 50 ohms; type RG-58/U; connectors, BNC. Tektronix Part No. 012-0057-01.

10. Five-nanosecond cable. Impedance, 50 ohms; type, RG-213/U; connectors, GR874. Tektronix Part No. 017-0502-00.

11. In-line GR termination. Impedance, 50 ohms; wattage rating, two watts; accuracy, $\pm 2\%$; connectors, GR874 input with BNC male output. Tektronix Part No. 017-0064-00.

12. Dual-input coupler.¹ Matched signal transfer to each input. Tektronix calibration fixture 067-0525-00.

13. 10X GR attenuator.² Impedance, 50 ohms; accuracy, $\pm 2\%$; connectors, GR874. Tektronix Part No. 017-0078-00.

14. In-line BNC termination.¹ Impedance, 50 ohms; wattage rating, two watts; accuracy, $\pm 2\%$; connectors, BNC. Tektronix Part No. 011-0049-01.

15. 10X BNC attenuator.¹ Impedance, 50 ohms; accuracy, $\pm 2\%$; connectors, BNC. Tektronix Part No. 011-0059-01.

16. Input RC normalizer.² Time constant, one megohm X 20 picofarads; attenuation, 2X; connectors, BNC. Tektronix calibration fixture 067-0538-00.

17. Adapter.² Adapts GR874 connector to BNC male connector. Tektronix Part No. 017-0064-00.

Adjustment Tools

18. Screwdriver. Three-inch shaft, 3/32-inch bit. For example, Xcelite R-3323.

19. Low-capacitance screwdriver.² 1 1/2-inch shaft. Tektronix Part No. 003-0000-00.

20. Tuning tool.² Handle with inserts for input capacitance and attenuator adjustments. Tektronix Part No. 003-0307-00, 003-0334-00, and 003-0497-00.

Preliminary Control Settings

Set the Indicator Oscilloscope and 7A18 controls as follows (for both Performance Check and Adjustment procedure):

Indicator Oscilloscope	
Intensity	Midrange
Focus	Adjust for well-defined display
Graticule Illum	As desired
Calibrator	40 mV
Rate	1 kHz
Vert Mode	Left
Trig Source	Left Vert
7A18	
DISPLAY MODE	CH 1
TRIGGER SOURCE	MODE
CH 2 POLARITY	+UP
CH 1 and CH 2	
POSITION	Midrange
VOLTS/DIV	10 mV
AC-GND-DC	DC

¹ Required only for Performance Check.
² Required only for Adjustment procedure.

PART I—PERFORMANCE CHECK

Introduction

The following procedure checks the performance of the 7A18 without removing the covers or making internal adjustments. All tolerances given in this procedure are based on Section 1 of this manual.

Index to Part I — Performance Check

1. Check Channel 1 and 2 GAIN	Page 5-3
2. Check Channel 1 and 2 Deflection Factor Accuracy	Page 5-3
3. Check Channel 1 and 2 VARIABLE (VOLTS/DIV) Range	Page 5-4
4. Check Channel 1 and 2 Trace IDENTIFY (7A18 only)	Page 5-4
5. Check Channel 1 and 2 Upper Bandwidth	Page 5-4
6. Check Channel 1 and 2 Lower Frequency Response	Page 5-4
7. Check Channel Isolation	Page 5-5
8. Check Common-Mode Rejection Ratio	Page 5-5
9. Check Alternate Operation	Page 5-5
10. Check Chopped Operation	Page 5-6
11. Check Trigger Source Operation	Page 5-6

Preliminary Procedure for Performance Check

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to +50°C range unless stated otherwise.

1. Install the 7A18 in the left vertical plug-in compartment of the Indicator Oscilloscope.

2. Connect the Indicator Oscilloscope to a power source which meets the frequency and voltage requirements of the oscilloscope power supply.

3. Turn the Indicator Oscilloscope power on. Allow at least twenty minutes warmup for checking the 7A18 to the given accuracy.

4. Set the controls as given under Preliminary Control Settings.

NOTE

The checks titled Channel 1 and 2 apply equally to both channels. Perform the check on the channel selected by the DISPLAY MODE switch.

1. Check Channel 1 and 2 GAIN

a. Connect the standard amplitude calibrator output to the CH 1 and CH 2 input connectors with the 42-inch BNC cable and dual-input coupler.

b. Set the standard amplitude calibrator for a 50-millivolt square-wave output.

c. CHECK—CRT display for a five-division display.

d. If necessary, adjust the front-panel GAIN control for exactly five divisions of vertical deflection. To adjust, press in the GAIN knob with a screwdriver and turn until the GAIN control is engaged.

e. Set the DISPLAY MODE switch to CH 2 and repeat parts c and d of this step for Channel 2.

2. Check Channel 1 and 2 Deflection Factor Accuracy

a. Set the Channel 1 AC-GND-DC switch to GND.

b. CHECK—Using the VOLTS/DIV and standard amplitude calibrator settings given in Table 5-1, check vertical deflection within 2% in each position of the VOLTS/DIV switch.

Performance Check—7A18/7A18N

c. Change the following control settings:

DISPLAY MODE	CH 1
CH 1 AC-GND-DC	DC
CH 2 AC-GND-DC	GND

d. Repeat part b of this step for Channel 1.

TABLE 5-1

Vertical Deflection Accuracy

VOLTS/DIV Switch Setting	Standard Amplitude Calibrator Output	Vertical Deflection in Divisions	Maximum Error for $\pm 2\%$ Accuracy (divisions)
5 mV	20 mV	4	± 0.08
10 mV	50 mV	5	Set in step 1
20 mV	0.1 V	5	± 0.1
50 mV	0.2 V	4	± 0.08
.1 V	0.5 V	5	± 0.1
.2 V	1 V	5	± 0.1
.5 V	2 V	4	± 0.08
1 V	5 V	5	± 0.1
2 V	10 V	5	± 0.1
5 V	20 V	4	± 0.08

3. Check Channel 1 and 2 VARIABLE (VOLTS/DIV) Range

a. Set the Channel 1 and 2 VOLTS/DIV switches to 10 mV and the standard amplitude calibrator for a 50-millivolt output.

b. Press and release the VARIABLE control to its outward position.

c. CHECK—With the VARIABLE control fully counter-clockwise, check for two divisions or less of deflection.

d. Return the VARIABLE control to the CAL IN position.

e. Change the following control settings:

DISPLAY MODE	CH 2
CH 1 AC-GND-DC	GND
CH 2 AC-GND-DC	DC

f. Repeat parts b, c, and d of this step for Channel 2.

4. Check Channel 1 and 2 Trace IDENTIFY (7A18 only)

a. Center the CRT display vertically with the 7A18 POSITION control.

b. CHECK—Press the IDENTIFY button and check that the trace moves upward.

c. Set the DISPLAY MODE switch to CH 1 and repeat parts a and b of this step for Channel 1.

d. Disconnect all test equipment.

5. Check Channel 1 and 2 Upper Bandwidth

a. Connect the medium-frequency constant-amplitude sine-wave generator to the 7A18 CH 1 input connector with the five-nanosecond GR cable and in-line 50-ohm GR termination.

b. Set the medium-frequency generator for an eight-division display (80 millivolts) at the 50-kilohertz reference frequency.

c. Increase the generator frequency until the display amplitude decreases to 5.6 divisions.

d. CHECK—Generator output frequency; must be at least 50 megahertz in a 7400-series mainframe, 60 megahertz in a 7500-series, or 75 megahertz in a 7700-series.

e. Disconnect the generator output from the CH 1 input connector and connect it to the CH 2 input connector.

f. Set the DISPLAY MODE switch to CH 2.

g. Repeat parts b, c, and d of this step for Channel 2.

h. CALIBRATION—See step 5 of the Adjustment procedure.

i. Disconnect all test equipment.

6. Check Channel 1 and 2 Lower Frequency Response

a. Change the following control settings:

CH 1 and CH 2

VOLTS/DIV	5 mV
AC-GND-DC	AC

b. Set the time-base unit for a free-running sweep at a rate of two milliseconds/division.

c. Connect the low-frequency constant-amplitude sine-wave generator to the CH 2 input connector with the 42-inch BNC cable, 10X BNC attenuator, and 50-ohm BNC termination.

d. Set the low-frequency generator for a six-division display (30 millivolts) at 10 kilohertz.

e. Decrease the generator frequency until the display amplitude decreases to 4.2 divisions.

f. CHECK—Generator frequency; must be 10 hertz or less.

g. Disconnect the low-frequency generator from the CH 2 input connector and connect it to the CH 1 input connector.

h. Set the DISPLAY MODE switch to CH 1.

i. Repeat parts d through f of this step for Channel 1.

j. Disconnect all test equipment.

7. Check Channel Isolation

a. Change the following control settings:

CH 1 and CH 2	DC
AC-GND-DC	
CH 1 VOLTS/DIV	.1 V
CH 2 VOLTS/DIV	5 mV

b. Connect the medium-frequency generator to the CH 1 input connector with the five-nanosecond GR cable and in-line 50-ohm GR termination.

c. Set the generator for a two-division display (200 millivolts) at 50 megahertz.

d. Change the following control settings:

DISPLAY MODE	CH 2
CH 1 VOLTS/DIV	10 mV

e. Check—CRT display for 0.4 division or less deflection (channel isolation display ratio 50:1 or better).

f. Disconnect the termination from Channel 1 and connect it to the CH 2 input connector.

g. Set the CH 2 VOLTS/DIV switch to .1 V.

h. Set the generator for a two-division display (200 millivolts) at 50 megahertz.

i. Change the following control settings:

CH 1 VOLTS/DIV	5 mV
DISPLAY MODE	CH 1

j. CHECK—CRT display for 0.4 division or less deflection.

k. Disconnect all test equipment.

8. Check Common-Mode Rejection Ratio

a. Change the following control settings:

CH 1 and CH 2 VOLTS/DIV	20 mV
-------------------------	-------

b. Connect the medium-frequency generator to the CH 1 and CH 2 input connectors with the five-nanosecond GR cable, in-line 50-ohm GR termination, and the dual-input coupler.

c. Set the constant-amplitude generator for an eight-division display (160 millivolts) at 50 megahertz.

d. Change the following control settings:

DISPLAY MODE	ADD
CH 2 POLARITY	INVERT

e. CHECK—CRT display for 0.8 division or less deflection (common-mode rejection ratio 10:1 or better).

f. Disconnect all test equipment.

9. Check Alternate Operation

a. Set the DISPLAY MODE switch to ALT.

b. Position the traces about two divisions apart.

Performance Check—7A18/7A18N

c. Turn the time-base unit time/division switch through-out its range.

d. CHECK—Trace alternation between channel 1 and 2 at all sweep rates. At faster sweep rates, alternation will not be apparent; instead display appears as two traces on the screen.

10. Check Chopped Operation

a. Set the DISPLAY MODE switch to CHOP.

b. CHECK—CRT display for two traces.

11. Check Trigger Source Operation

a. Change the following control settings:

DISPLAY MODE	ALT
TRIGGER SOURCE	CH 1

b. Connect the Indicator Oscilloscope Cal Out connector to the CH 1 input connector with the 18-inch BNC cable.

c. Set the time-base unit for a triggered display at a sweep rate of 0.5 millisecond/division.

d. Connect the low-frequency generator to the CH 2 input connector with the 42-inch BNC cable.

e. Set the generator for a two-division (40 millivolts) one-kilohertz signal.

f. CHECK—CRT display for square wave and sine wave; square wave only is stable.

g. Set the TRIGGER SOURCE switch to MODE.

h. CHECK—CRT display; square wave and sine wave are both stable.

i. Set the TRIGGER SOURCE switch to CH 2.

j. CHECK—CRT display; sine wave only is stable.

k. Disconnect all test equipment.

This completes the Performance Check procedure for the 7A18. If the instrument has met all tolerances given in this procedure, it is correctly calibrated and within the specified limits.

NOTES

This image shows a single page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or printed text on the page.

PART II-ADJUSTMENT

Introduction

The following procedure returns the 7A18 to correct calibration. All limits and tolerances given in this procedure are calibration guides, and should not be interpreted as instrument specifications except as listed in the Performance Requirement column of Section 1. The actual operation of the instrument may exceed the given limits or tolerances if the instrument meets the Performance Requirements as checked in Part I — Performance Check of this section.

Index to Part II — Adjustment

1. Adjust Channel 1 and 2 DC Balance	Page 5-7
2. Adjust Channel 1 and 2 GAIN	Page 5-8
3. Adjust Channel 1 and 2 Input Capacitance	Page 5-8
4. Adjust Channel 1 and 2 Attenuator Compensation	Page 5-9
5. Adjust Channel 1 and 2 High-Frequency Compensation	Page 5-10

Preliminary Procedure For Adjustment

NOTE

This instrument should be adjusted at an ambient temperature of $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for best overall accuracy.

1. Remove the left side shield from the 7A18, and the left side panel from the Indicator Oscilloscope.
2. Install the 7A18 in the left vertical plug-in compartment of the Indicator Oscilloscope.
3. Connect the Indicator Oscilloscope to a power source which meets the frequency and voltage requirements of the oscilloscope power supply.
4. Turn the Indicator Oscilloscope power on. Allow at least twenty minutes warmup before proceeding.

5. Set the controls as given under Preliminary Control Settings.

6. Adjust the Focus and Astigmatism as necessary to obtain a well-defined display.

NOTE

Titles for external controls of this instrument are capitalized in this procedure (e.g., VOLTS/DIV). Internal adjustments are initial capitalized only (e.g., DC Balance).

Location of Adjustments

The locations of the 7A18 adjustments are shown in Fig. 5-1.

1. Adjust Channel 1 and 2 DC Balance

- a. Position the trace to the center horizontal line with the CH 1 POSITION control.
- b. Push and release the CH 1 VARIABLE (VOLTS/DIV) control to its outward position.

c. CHECK—Turn the VARIABLE control from fully counterclockwise to fully clockwise. Trace should not move more than 0.5 division vertically.

d. ADJUST—Channel 1 DC Balance, adjustment number 1, for minimum trace shift as the CH 1 VARIABLE control is rotated from fully counterclockwise to fully clockwise.

e. Set the CH 1 VARIABLE control to the CAL IN position.

f. Set the DISPLAY MODE switch to CH 2.

g. Position the trace to the center horizontal line with the CH 2 POSITION control.

h. Push and release the CH 2 VARIABLE control to its outward position.

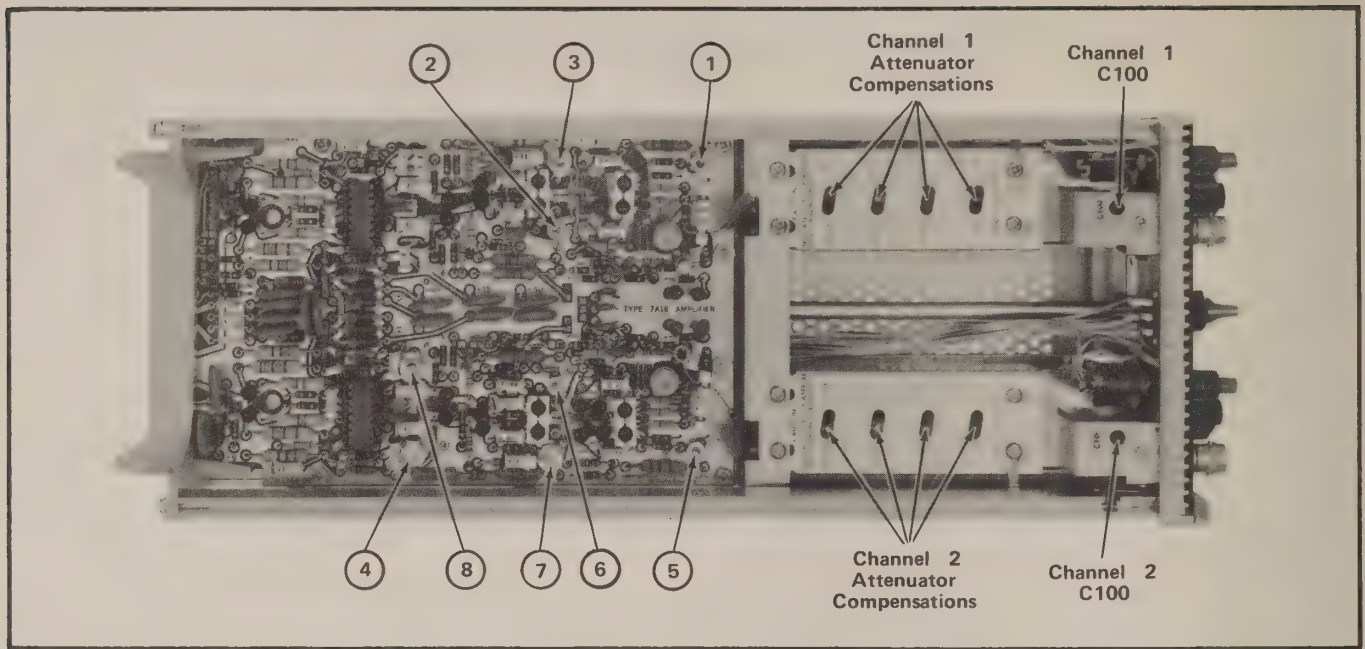


Fig. 5-1. Locations of adjustments used in this procedure. (7A18 shown.)

i. CHECK—Turn the VARIABLE control from fully counterclockwise to fully clockwise. Trace should not move more than 0.5 division vertically.

j. ADJUST—Channel 2 DC Balance, adjustment number 5, for minimum trace shift as the CH 2 VARIABLE control is rotated from fully counterclockwise to fully clockwise.

k. Set the CH 2 VARIABLE control to the CAL IN position.

2. Adjust Channel 1 and 2 GAIN

a. Connect the standard amplitude calibrator to the CH 2 input connector with the 42-inch BNC cable.

b. Set the standard amplitude calibrator for 50-millivolt square-wave output.

c. Position the display to the center of the graticule with the CH 2 POSITION control.

d. CHECK—CRT display for exactly five divisions in amplitude.

e. ADJUST—CH 2 GAIN adjustment (front panel) for exactly five divisions of deflection. To adjust, press in the GAIN knob with a screwdriver and turn until the GAIN control is engaged.

f. Disconnect the standard amplitude calibrator from the CH 2 input connector and connect it to the CH 1 input connector.

g. Set the DISPLAY MODE switch to CH 1.

h. Position the display to the center of the graticule with the CH 1 POSITION control.

i. CHECK—CRT display for exactly five divisions in amplitude.

j. ADJUST—CH 1 GAIN adjustment (front panel) for exactly five divisions of deflection.

k. Disconnect all test equipment.

3. Adjust Channel 1 and 2 Input Capacitance

a. Remove the 7A18 from the Indicator Oscilloscope. Place the 7A18 on the plug-in extender and plug the extender into the left vertical compartment.

b. Set the CH 1 and CH 2 VOLTS/DIV switches to 5 mV.

c. Connect the square-wave generator high-amplitude output to the CH 1 input connector with the five-

nanosecond GR cable, 10X GR attenuator, in-line 50-ohm GR termination, and 20 pF normalizer.

d. Set the square-wave generator for a six-division display (30 millivolts) of a one-kilohertz signal.

e. Set the time-base unit for a triggered display at a sweep rate of .2 millisecond/division.

f. CHECK—CRT display for square-wave with square corner.

g. ADJUST—Channel 1 C100 for optimum square corner on the displayed waveform (use tuning tool).

h. Disconnect the normalizer from the CH 1 input connector and connect it to the CH 2 input connector.

i. Set the DISPLAY MODE switch to CH 2.

j. CHECK—CRT display for square-wave with square corner.

k. ADJUST—Channel 2 C100 for optimum square corner on the displayed waveform.

l. Disconnect all test equipment.

m. Remove the 7A18 and plug-in extender from the Indicator Oscilloscope. Install the 7A18 only in the left vertical compartment.

4. Adjust Attenuator Compensation

a. Connect the square-wave generator high-amplitude output to the CH 2 input connector with the five-nanosecond GR cable, 10X GR attenuator, in-line 50-ohm GR termination, and 20 pF normalizer.

b. Set the CH 1 and CH 2 VOLTS/DIV switches to 10 mV.

c. Set the square-wave generator for a six-division display (60 millivolts) of one-kilohertz signal.

d. CHECK—CRT display at each CH 2 VOLTS/DIV switch position listed in Table 5-2 for square corner and flat

top within 0.15 division. Re-adjust the generator output at each switch position to provide six divisions of deflection.

e. ADJUST—CH 2 attenuator compensations as given in Table 5-2 for optimum square corner and flat top on the displayed waveform (use tuning tool). Re-adjust the generator output at each switch position to provide six divisions of deflection.

f. Disconnect the normalizer from CH 2 and connect the signal to the CH 1 input connector.

g. Set the DISPLAY MODE switch to CH 1.

h. CHECK—CRT display at each CH 1 VOLTS/DIV switch position listed in Table 5-2 for square corner and flat top within 0.15 division. Re-adjust the generator output at each switch position to provide six divisions of deflection.

i. ADJUST—CH 1 attenuator compensations as given in Table 5-2 for optimum square corner and flat top on the displayed waveform. Re-adjust the generator output at each switch position to provide six divisions of deflection.

j. Disconnect all test equipment.

TABLE 5-2

Attenuator Compensation

VOLTS/DIV Switch Setting	Adjust for Optimum	
	Square Corner	Flat Top
10 mV	C106	C107
20 mV	C110	C111
50 mV	C114	C115
0.1 V	Check	Check

Remove 10X GR attenuator.

0.2 V	Check	Check
0.5 V	C118	C119
1 V	Check	Check

Replace in-line 50-ohm GR termination with GR to BNC male adapter.

2 V	Check	Check
5 V	Check	Check

5. Adjust Channel 1 and 2 High-Frequency Compensation

a. Set the CH 1 and CH 2 VOLTS/DIV switches to 5 mV.

b. Connect the square-wave generator fast-rise output to the CH 1 input connector with the five-nanosecond GR cable, 10X GR attenuator, and in-line 50-ohm GR termination.

c. Set the square-wave generator for a six-division display (30 millivolts) of a 100 kilohertz signal.

d. Set the time-base unit for a triggered display at a sweep rate of 2 microseconds/division.

NOTE

In the following steps, change the time-base unit magnifier from X1 to X10 and compare the response at both sweep rates.

e. CHECK—CRT display for optimum square-wave response with aberrations not to exceed 0.24 division peak-to-peak.

f. ADJUST—Adjustments numbers 2, 3, and 4 for optimum square-wave response with minimum aberrations. Use the low-capacitance screwdriver to adjust the variable capacitors. Repeat these adjustments until optimum response is obtained.

g. Disconnect the termination from the CH 1 input connector and connect it to the CH 2 input connector.

h. Set the DISPLAY MODE switch to CH 2.

i. CHECK—CRT display for optimum square-wave response with aberrations not to exceed 0.24 division peak-to-peak.

j. ADJUST—Adjustments numbers 6, 7, and 8 for optimum square-wave response with minimum aberrations. Use the low-capacitance screwdriver to adjust the variable capacitors. Repeat these adjustments until optimum response is obtained.

This completes the Calibration of the 7A18. Disconnect all test equipment. Replace the left side shield on the 7A18 and the left side panel on the Indicator Oscilloscope.

PARTS LIST ABBREVIATIONS

BHB	binding head brass	int	internal
BHS	binding head steel	lg	length or long
cap.	capacitor	met.	metal
cer	ceramic	mtg hdw	mounting hardware
comp	composition	OD	outside diameter
conn	connector	OHB	oval head brass
CRT	cathode-ray tube	OHS	oval head steel
csk	countersunk	P/O	part of
DE	double end	PHB	pan head brass
dia	diameter	PHS	pan head steel
div	division	plstc	plastic
elect.	electrolytic	PMC	paper, metal cased
EMC	electrolytic, metal cased	poly	polystyrene
EMT	electrolytic, metal tubular	prec	precision
ext	external	PT	paper, tubular
F & I	focus and intensity	PTM	paper or plastic, tubular, molded
FHB	flat head brass	RHB	round head brass
FHS	flat head steel	RHS	round head steel
Fil HB	fillister head brass	SE	single end
Fil HS	fillister head steel	SN or S/N	serial number
h	height or high	S or SW	switch
hex.	hexagonal	TC	temperature compensated
HHB	hex head brass	THB	truss head brass
HHS	hex head steel	thk	thick
HSB	hex socket brass	THS	truss head steel
HSS	hex socket steel	tub.	tubular
ID	inside diameter	var	variable
inc	incandescent	w	wide or width
		WW	wire-wound

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

×000	Part first added at this serial number
00×	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.

SECTION 6

ELECTRICAL PARTS LIST

7A18/7A18N

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
----------	-----------------------	-------------------------	------	-------------

CHASSIS

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C9 ¹	283-0000-00		0.001 μ F	Cer	500 V	
C10	285-0816-01		0.019 μ F	Plastic		10%
C13 ¹	283-0000-00		0.001 μ F	Cer	500 V	
C19 ¹	283-0000-00		0.001 μ F	Cer	500 V	
C20	285-0816-01		0.019 μ F	Plastic		10%
C23 ¹	283-0000-00		0.001 μ F, Cer,	Cer	500 V	
C238	281-0504-00		10 pF	Cer	500 V	10%
C438	281-0504-00		10 pF	Cer	500 V	10%

Connectors

J10 ¹	131-0679-00		BNC, receptacle, electrical
J10 ²	131-0126-00		BNC, receptacle, electrical
J20 ¹	131-0679-00		BNC, receptacle, electrical
J20 ²	131-0126-00		BNC, receptacle, electrical

Inductors

L237	276-0507-00		Core, ferramic suppressor
L437	276-0507-00		Core, ferramic suppressor
	276-0549-00 (2)		

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R10 ₃	315-0620-00		62 Ω	1/4 W	5%
R11 ₃	311-0880-01	B010100 B029999	5 k Ω , Var		
R11 ₂	311-1320-00	B030000	5 k Ω , Var		
R11 ₁	311-0310-00		5 k Ω , Var		
R13 ¹	317-0910-00		91 Ω	1/8 W	5%
R20 ₄	315-0620-00		62 Ω	1/4 W	5%
R21 ₄	311-0880-01	B010100 B029999	5 k Ω , Var		
R21 ₂	311-1320-00	B030000	5 k Ω , Var		
R21 ²	311-0310-00		5 k Ω , Var		

¹7A18 only.

²7A18N only.

³Furnished as a unit with S13, 7A18 only.

⁴Furnished as a unit with S23, 7A18 only.

CHASSIS (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Resistors (cont)			
R23 ¹	317-0910-00	91 Ω	1/8 W 5%
R35	315-0241-00	240 Ω	1/4 W 5%
R36	315-0621-00	620 Ω	1/4 W 5%
R38	315-0392-00	3.9 k Ω	1/4 W 5%
R236	315-0621-00	620 Ω	1/4 W 5%
R237 A, B ²	311-1131-01	5 k Ω x 5 k Ω , Var	
R238	315-0131-00	130 Ω	1/4 W 5%
R436	315-0621-00	620 Ω	1/4 W 5%
R437 A, B ³	311-1131-01	5 k Ω x 5 k Ω , Var	
R438	315-0131-00	130 Ω	1/4 W 5%

Switches

Wired or Unwired

S13 ⁴			IDENTIFY
S22	260-0816-00	Slide	CH2 POLARITY
S23 ⁵			IDENTIFY
S30 A, B Wired	*262-0926-00	Rotary	DISPLAY MODE/TRIGGER SOURCE
S30 A, B	260-1221-00	Rotary	DISPLAY MODE/TRIGGER SOURCE
S237 ⁶ Wired	*262-0928-00	Rotary	CAL IN
S437 ⁷ Wired	*262-0928-00	Rotary	CAL IN

A1 ATTENUATOR Circuit Board Assembly (2)

*670-1386-00

Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C100	281-0064-00	0.25-1.5 pF, Var	Plastic	
C101	281-0661-00	0.8 pF Cer	500 V	± 0.1 pF
C106	*307-1010-00	Attenuator Strip	2X	
C107	*307-1010-00	Attenuator Strip	2X	
C110	*307-1011-00	Attenuator Strip	4X	

- ¹7A18 only.
²Furnished as a unit with S237.
³Furnished as a unit with S437.
⁴Furnished as a unit with R11, 7A18 only
⁵Furnished as a unit with R21, 7A18 only
⁶Furnished as a unit with R237 A, B.
⁷Furnished as a unit with R437 A, B.

A1 ATTENUATOR Circuit Board Assembly (2) (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Capacitors (cont)			
C111	*307-1011-00	Attenuator Strip	4X
C114	*307-1013-00	Attenuator Strip	10X
C115	*307-1013-00	Attenuator Strip	10X
C118	*307-1014-00	Attenuator Strip	100X
C119	*307-1014-00	Attenuator Strip	100X

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R102	317-0105-00	1 M Ω	1/8 W		5%
R130	322-0481-01	1 M Ω	1/4 W	Prec	1/2%

Switch

Wired or Unwired

S100 A ¹	Cam	AC/GND/DC
S100 B		VOLTS/DIV
S100 C		VOLTS/DIV

A2 AMPLIFIER Circuit Board Assembly

*670-1384-00

Complete Board

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C210	283-0001-00	0.005 μ F	Cer	500 V	
C212	281-0557-00	1.8 pF	Cer	500 V	
C216	290-0512-00	22 μ F	Elect.	15 V	
C225	281-0638-00	240 pF	Cer	500 V	5%
C241	281-0580-00	470 pF	Cer	500 V	10%
C245	281-0153-00	1.7-11 pF, Var	Air	250 V	
C246	281-0512-00	27 pF	Cer	500 V	10%
C256	283-0000-00	0.001 μ F	Cer	500 V	
C257	283-0000-00	0.001 μ F	Cer	500 V	
C264	281-0600-00	35 pF	Cer		10%

¹See Mechanical Parts List for replacement parts.

A2 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Capacitors (cont)						
C270	283-0000-00	0.001 μF	Cer	500 V	±0.5 pF	
C274	281-0592-00	4.7 pF	Cer			
C275	281-0153-00	1.7-11 pF, Var	Air	250 V		
C278	281-0523-00	100 pF	Cer	350 V		
C313	283-0000-00	0.001 μF	Cer	500 V		
C318	290-0512-00	22 μF	Elect.	15 V	5%	
C325	281-0638-00	240 pF	Cer	500 V		
C341	281-0580-00	470 pF	Cer	500 V		10%
C345	281-0578-00	18 pF	Cer	500 V		5%
C356	283-0000-00	0.001 μF	Cer	500 V		
C364	281-0600-00	35 pF	Cer		10%	
C370	283-0000-00	0.001 μF	Cer	500 V	±0.5 pF	
C374	281-0592-00	4.7 pF	Cer			
C375	281-0153-00	1.7-11 pF, Var	Air	250 V		
C378	281-0523-00	100 pF	Cer	350 V		
C391	283-0002-00	0.01 μF	Cer	500 V		
C392	283-0002-00	0.01 μF	Cer	500 V		
C393	283-0002-00	0.01 μF	Cer	500 V		
C394	283-0002-00	0.01 μF	Cer	500 V		
C395	283-0002-00	0.01 μF	Cer	500 V		
C396	283-0002-00	0.01 μF	Cer	500 V		
C397	283-0002-00	0.01 μF	Cer	500 V		
C398	283-0002-00	0.01 μF	Cer	500 V		
C410	283-0001-00	0.005 μF	Cer	500 V		
C412	281-0557-00	1.8 pF	Cer	500 V		
C416	290-0512-00	22 PF	Elect.	15 V	5%	
C425	281-0638-00	240 pF	Cer	500 V		
C427	283-0000-00	0.001 μF	Cer	500 V		
C429	283-0000-00	0.001 μF	Cer	500 V		
C441	281-0580-00	470 pF	Cer	500 V		10%
C445	281-0153-00	1.7-11 pF, Var	Air	250 V	5%	
C446	281-0578-00	18 pF	Cer	500 V		
C456	283-0000-00	0.001 μF	Cer	500 V		
C457	283-0000-00	0.001 μF	Cer	500 V		
C464	281-0600-00	35 pF	Cer			10%

A2 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description
Capacitors (cont)			
C470	283-0000-00	0.001 μ F	Cer 500 V
C474	281-0592-00	4.7 pF	Cer ± 0.5 pF
C475	281-0503-00	8 pF	Cer 500 V ± 0.5 pF
C478	281-0523-00	100 pF	Cer 350 V
C513	283-0000-00	0.001 μ F	Cer 500 V
C518	290-0512-00	22 μ F	Elect. 15 V
C525	281-0638-00	240 pF	Cer 500 V 5%
C527	283-0000-00	0.001 μ F	Cer 500 V
C541	281-0580-00	470 pF	Cer 500 V 10%
C545	281-0512-00	27 pF	Cer 500 V 10%
C556	283-0000-00	0.001 μ F	Cer 500 V
C564	281-0600-00	35 pF	Cer 10%
C570	283-0000-00	0.001 μ F	Cer 500 V
C574	281-0592-00	4.7 pF	Cer ± 0.5 pF
C575	281-0503-00	8 pF	Cer 500 V ± 0.5 pF
C578	281-0523-00	100 pF	Cer 350 V
C584	283-0000-00	0.001 μ F	Cer 500 V
C591	283-0002-00	0.01 μ F	Cer 500 V
C592	283-0002-00	0.01 μ F	Cer 500 V
C593	283-0002-00	0.01 μ F	Cer 500 V
C594	283-0002-00	0.01 μ F	Cer 500 V
C595	283-0002-00	0.01 μ F	Cer 500 V
C596	283-0002-00	0.01 μ F	Cer 500 V
Semiconductor Device, Diodes			
CR210	152-0321-00	Silicon	Tek Spec, Dual
CR220	*152-0185-00	Silicon	Replaceable by 1N4152
CR221	*152-0185-00	Silicon	Replaceable by 1N4152
CR357	*152-0185-00	Silicon	Replaceable by 1N4152
CR410	152-0321-00	Silicon	Tek Spec, Dual
CR420	*152-0185-00	Silicon	Replaceable by 1N4152
CR421	*152-0185-00	Silicon	Replaceable by 1N4152
CR557	*152-0185-00	Silicon	Replaceable by 1N4152

A2 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
Inductors						
LR391	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
LR393	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
LR395	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
LR396	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
LR397	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
LR591	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
LR592	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
LR595	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
LR596	*108-0184-00			3.2 μ H (wound on a 10 Ω , 1/2 W, 5% resistor)		
Transistors						
Q210 ¹ A, B	151-1032-00		Silicon	FET	TO-5	Dual
Q220 ¹	*153-0596-00		Silicon	NPN		2N3563
Q225	151-0225-00		Silicon	NPN	TO-18	2N3563
Q240 ²	*153-0597-00		Silicon	PNP		2N4258
Q250	151-0221-00		Silicon	PNP	TO-18	2N4258
Q260	151-0225-00		Silicon	NPN	TO-18	2N3563
Q280	151-0221-00		Silicon	PNP	TO-18	2N4258
Q320 ¹	*153-0596-00		Silicon	NPN		2N3563
Q325	151-0225-00		Silicon	NPN	TO-18	2N3563
Q340 ²	*153-0597-00		Silicon	PNP		2N4258
Q350	151-0221-00		Silicon	PNP	TO-18	2N4258
Q360	151-0225-00		Silicon	NPN	TO-18	2N3563
Q380	151-0221-00		Silicon	PNP	TO-18	2N4258
Q410 ³ A, B	151-1032-00		Silicon	FET	TO-5	Dual
Q420	*153-0596-00		Silicon	NPN		2N3563

¹Q220 & Q320 furnished as a matched pair.²Q240 & Q340 furnished as a matched pair.³Q420 & Q520 furnished as a matched pair.

A2. AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Transistors (cont)						
Q425 ¹	*153-0595-00	Silicon	NPN		2N3563	
Q426 ¹	*153-0595-00	Silicon	NPN		2N3563	
Q440	151-0221-00	Silicon	PNP	TO-18	2N4258	
Q450	151-0221-00	Silicon	PNP	TO-18	2N4258	
Q460	151-0225-00	Silicon	NPN	TO-18	2N3563	
Q480	151-0221-00	Silicon	PNP	TO-18	2N4258	
Q520 ²	*153-0596-00	Silicon	NPN		2N3563	
Q525 ¹	*153-0595-00	Silicon	NPN		2N3563	
Q526 ¹	*153-0595-00	Silicon	NPN		2N3563	
Q540	151-0221-00	Silicon	PNP	TO-18	2N4258	
Q550	151-0221-00	Silicon	PNP	TO-18	2N4258	
Q560	151-0225-00	Silicon	NPN	TO-18	2N3563	
Q580	151-0221-00	Silicon	PNP	TO-18	2N4258	
Resistors						
Resistors are fixed, composition, ±10% unless otherwise indicated.						
R32	315-0123-00	12 kΩ	1/4 W			5%
R210	316-0474-00	470 kΩ	1/4 W			
R211	316-0470-00	47 Ω	1/4 W			
R212	315-0561-00	560 Ω	1/4 W			5%
R215	315-0391-00	390 Ω	1/4 W			5%
R216	315-0911-00	910 Ω	1/4 W			5%
R218	321-0032-00	21 Ω	1/8 W		Prec	1%
R222	321-0153-00	383 Ω	1/8 W		Prec	1%
R223	323-0257-00	4.64 kΩ	1/2 W		Prec	1%
R224	321-0032-00	21 Ω	1/8 W		Prec	1%
R225	315-0471-00	470 Ω	1/4 W			5%
R226	321-0122-00	182 Ω	1/8 W		Prec	1%
R227	315-0821-00	820 Ω	1/4 W			5%
R241	315-0241-00	240 Ω	1/4 W			5%
R243	323-0255-00	4.42 kΩ	1/2 W		Prec	1%
R244	321-0126-00	200 Ω	1/8 W		Prec	1%
R245	311-0634-00	500 Ω, Var				
R246	315-0103-00	10 kΩ	1/4 W			5%
R250	321-0105-00	121 Ω	1/8 W		Prec	1%
R251	321-0137-00	261 Ω	1/8 W		Prec	1%

¹Q425 & Q525 and Q426 & Q526 furnished as a matched quad.

²Q520 & Q420 furnished as a matched pair.

A2 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description		
Resistors (cont)					
R256	315-0471-00	470 Ω	1/4 W		5%
R257	315-0153-00	15 k Ω	1/4 W		5%
R259	315-0103-00	10 k Ω	1/4 W		5%
R260	316-0101-00	100 Ω	1/4 W		
R263	315-0272-00	2.7 k Ω	1/4 W		5%
R264	316-0330-00	33 Ω	1/4 W		
R274	315-0182-00	1.8 k Ω	1/4 W		5%
R275	315-0100-00	10 Ω	1/4 W		5%
R276	321-0059-00	40.2 Ω	1/8 W	Prec	1%
R277	321-0059-00	40.2 Ω	1/8 W	Prec	1%
R278	323-0189-00	909 Ω	1/2 W	Prec	1%
R280	316-0330-00	33 Ω	1/4 W		
R282	323-0150-00	357 Ω	1/2 W	Prec	1%
R284	316-0121-00	120 Ω	1/4 W		
R286	323-0206-00	1.37 k Ω	1/2 W	Prec	1%
R313	316-0105-00	1 M Ω	1/4 W		
R317	321-0032-00	21 Ω	1/8 W	Prec	1%
R318	315-0911-00	910 Ω	1/4 W		5%
R319	315-0391-00	390 Ω	1/4 W		5%
R321	311-0633-00	5 k Ω , Var			
R322	315-0432-00	4.3 k Ω	1/4 W		5%
R323	315-0131-00	130 Ω	1/4 W		5%
R324	321-0032-00	21 Ω	1/8 W	Prec	1%
R325	315-0471-00	470 Ω	1/4 W		5%
R326	321-0122-00	182 Ω	1/8 W	Prec	1%
R327	315-0361-00	360 Ω	1/4 W		5%
R341	315-0241-00	240 Ω	1/4 W		5%
R343	323-0255-00	4.42 k Ω	1/2 W	Prec	1%
R345	315-0392-00	3.9 k Ω	1/4 W		5%
R350	323-0153-00	383 Ω	1/2 W	Prec	1%
R351	321-0137-00	261 Ω	1/8 W	Prec	1%
R356	315-0471-00	470 Ω	1/4 W		5%
R357	316-0274-00	270 k Ω	1/4 W		
R358	316-0222-00	2.2 k Ω	1/4 W		
R359	315-0122-00	1.2 k Ω	1/4 W		5%
R363	315-0272-00	2.7 k Ω	1/4 W		5%
R364	316-0330-00	33 Ω	1/4 W		
R370	321-0217-00	1.78 k Ω	1/8 W	Prec	1%
R374	315-0182-00	1.8 k Ω	1/4 W		5%
R375	315-0100-00	10 Ω	1/4 W		5%
R376	321-0059-00	40.2 Ω	1/8 W	Prec	1%
R377	321-0059-00	40.2 Ω	1/8 W	Prec	1%

A2 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	No. Disc	Description		
Resistors (cont)						
R378	323-0189-00		909 Ω	1/2 W	Prec	1%
R380	316-0330-00		33 Ω	1/4 W		
R382	323-0150-00		357 Ω	1/2 W	Prec	1%
R384	316-0121-00		120 Ω	1/4 W		
R386	323-0206-00		1.37 k Ω	1/2 W	Prec	1%
R390	316-0470-00		47 Ω	1/4 W		
R400	316-0152-00		1.5 k Ω	1/4 W		
R401	316-0101-00		100 Ω	1/4 W		
R410	316-0474-00		470 k Ω	1/4 W		
R411	316-0470-00		470 Ω	1/4 W		
R412	315-0561-00		560 Ω	1/4 W		5%
R415	315-0391-00		390 Ω	1/4 W		5%
R416	315-0911-00		910 Ω	1/4 W		5%
R418	321-0032-00		21 Ω	1/8 W	Prec	1%
R422	321-0153-00		383 Ω	1/8 W	Prec	1%
R423	323-0257-00		4.64 k Ω	1/2 W	Prec	1%
R424	321-0032-00		21 Ω	1/8 W	Prec	1%
R425	315-0471-00		470 Ω	1/4 W		5%
R426	321-0122-00		182 Ω	1/8 W	Prec	1%
R427	315-0821-00		820 Ω	1/4 W		5%
R428	315-0241-00		240 Ω	1/4 W		5%
R429	315-0821-00		820 Ω	1/4 W		5%
R441	315-0241-00		240 Ω	1/4 W		5%
R443	323-0255-00		4.42 k Ω	1/2 W	Prec	1%
R444	321-0126-00		200 Ω	1/8 W	Prec	1%
R445	311-0634-00		500 Ω , Var			
R446	315-0392-00		3.9 k Ω	1/4 W		5%
R450	321-0110-00		137 Ω	1/8 W	Prec	1%
R451	321-0137-00		261 Ω	1/8 W	Prec	1%
R455	315-0272-00		2.7 k Ω	1/4 W		5%
R456	315-0471-00		470 Ω	1/4 W		5%
R459	315-0103-00		10 k Ω	1/4 W		5%
R460	316-0101-00		100 Ω	1/4 W		
R463	315-0272-00		2.7 k Ω	1/4 W		5%
R464	316-0330-00		33 Ω	1/4 W		
R474	315-0182-00		1.8 k Ω	1/4 W		5%
R475	315-0100-00		10 Ω	1/4 W		5%
R476	321-0059-00		40.2 Ω	1/8 W	Prec	1%
R477	321-0059-00		40.2 Ω	1/8 W	Prec	1%
R478	323-0189-00		909 Ω	1/2 W	Prec	1%

A2 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description		
Resistors (cont)					
R480	316-0330-00	33 Ω	1/4 W		
R482	323-0150-00	357 Ω	1/2 W	Prec	1%
R484	316-0331-00	330 Ω	1/4 W		
R486	323-0206-00	1.37 k Ω	1/2 W	Prec	1%
R513	316-0105-00	1 M Ω	1/4 W		
R517	321-0032-00	21 Ω	1/8 W	Prec	1%
R518	315-0911-00	910 Ω	1/4 W		5%
R519	315-0391-00	390 Ω	1/4 W		5%
R521	311-0633-00	5 k Ω , Var			
R522	315-0432-00	4.3 k Ω	1/4 W		5%
R523	315-0131-00	130 Ω	1/4 W		5%
R524	321-0032-00	21 Ω	1/8 W	Prec	1%
R525	315-0471-00	470 Ω	1/4 W		5%
R526	321-0122-00	182 Ω	1/8 W	Prec	1%
R527	315-0621-00	620 Ω	1/4 W		5%
R529	315-0621-00	620 Ω	1/4 W		5%
R541	315-0241-00	240 Ω	1/4 W		5%
R543	323-0255-00	4.42 k Ω	1/2 W	Prec	1%
R545	315-0103-00	10 k Ω	1/4 W		5%
R550	323-0153-00	383 Ω	1/2 W	Prec	1%
R551	321-0137-00	261 Ω	1/8 W	Prec	1%
R555	315-0272-00	2.7 k Ω	1/4 W		5%
R556	315-0471-00	470 Ω	1/4 W		5%
R557	316-0274-00	270 k Ω	1/4 W		
R558	316-0222-00	2.2 k Ω	1/4 W		
R559	315-0122-00	1.2 k Ω	1/4 W		5%
R563	315-0272-00	2.7 k Ω	1/4 W		5%
R564	316-0330-00	33 Ω	1/4 W		
R570	321-0217-00	1.78 k Ω	1/8 W	Prec	1%
R574	315-0182-00	1.8 k Ω	1/4 W		5%
R575	315-0100-00	10 Ω	1/4 W		5%
R576	321-0059-00	40.2 Ω	1/8 W	Prec	1%
R577	321-0059-00	40.2 Ω	1/8 W	Prec	1%
R578	323-0189-00	909 Ω	1/2 W	Prec	1%
R580	316-0330-00	33 Ω	1/4 W		
R582	323-0150-00	357 Ω	1/2 W	Prec	1%
R584	316-0331-00	330 Ω	1/4 W		
R586	323-0206-00	1.37 k Ω	1/2 W	Prec	1%
R590	316-0470-00	47 Ω	1/4 W		

A2 AMPLIFIER Circuit Board Assembly (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
Integrated Circuits				
U270	*155-0022-00		Monolithic	
U470	*155-0022-00		Monolithic	

A3 READOUT Circuit Board Assembly (2)

*670-1385-00¹ Complete Board, 7A18 only

Capacitors

Tolerance $\pm 20\%$ unless otherwise indicated.

C621	283-0000-00	0.001 μ F	Cer	500 V
C630	283-0000-00	0.001 μ F	Cer	500 V
C631	283-0000-00	0.001 μ F	Cer	500 V
C634	283-0000-00	0.001 μ F	Cer	500 V
C635	283-0000-00	0.001 μ F	Cer	500 V
C638	283-0000-00	0.001 μ F	Cer	500 V
C639	283-0000-00	0.001 μ F	Cer	500 V
C641	283-0000-00	0.001 μ F	Cer	500 V
C643	283-0000-00	0.001 μ F	Cer	500 V
C647	283-0000-00	0.001 μ F	Cer	500 V
C648	283-0003-00	0.01 μ F	Cer	150 V
C649	283-0000-00	0.001 μ F	Cer	500 V

Semiconductor Device, Diodes

CR621	*152-0185-00	Silicon	Replaceable by 1N4152
CR647	*152-0185-00	Silicon	Replaceable by 1N4152

Transistor

Q620	151-0254-00	Silicon	NPN	TO-98	2N5308
------	-------------	---------	-----	-------	--------

Resistors

Resistors are fixed, composition, $\pm 10\%$ unless otherwise indicated.

R621	321-0223-00	2.05 k Ω	1/8 W	Prec	1%
R622	321-0296-00	11.8 k Ω	1/8 W	Prec	1%
R630	315-0154-00	150 k Ω	1/4 W		5%
R631	315-0753-00	75 k Ω	1/4 W		5%
R633	315-0753-00	75 k Ω	1/4 W		5%

¹ Included with *672-0020-00 ATTENUATOR Circuit Board Assembly.

ELECTRICAL PARTS LIST-7A18/7A18N

A3 READOUT Circuit Board Assembly (2) (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff Disc	Description			
Resistors (cont)						
R634	315-0154-00	150 kΩ	1/4 W	Prec		5%
R635	321-0344-00	37.4 kΩ	1/8 W			1%
R637	315-0154-00	150 kΩ	1/4 W			5%
R638	315-0154-00	150 kΩ	1/4 W			5%
R639	315-0753-00	75 kΩ	1/4 W			5%
R640	315-0753-00	75 kΩ	1/4 W	Prec		5%
R641	315-0154-00	150 kΩ	1/4 W			5%
R642	315-0513-00	51 kΩ	1/4 W			5%
R643	321-0344-00	37.4 kΩ	1/8 W			1%
R645	315-0154-00	150 kΩ	1/4 W			5%
R646	315-0154-00	150 kΩ	1/4 W			5%
R647	315-0133-00	13 kΩ	1/4 W			5%
R648	315-0154-00	150 kΩ	1/4 W			5%

SECTION 7

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols and Reference Designators

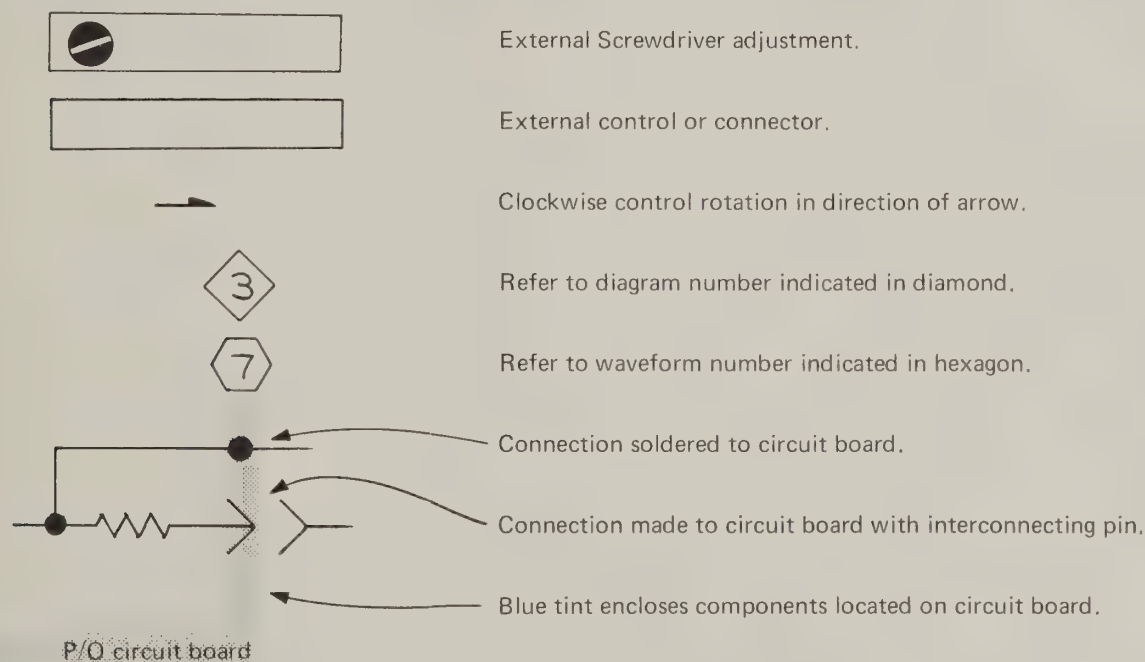
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors =	Values one or greater are in picofarads (pF).
	Values less than one are in microfarads (μ F).
Resistors =	Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

A	Assembly, separable or repairable (circuit board, etc.)	LR	Inductor/resistor combination
AT	Attenuator, fixed or variable	M	Meter
B	Motor	Q	Transistor or silicon-controlled rectifier
BT	Battery	P	Connector, movable portion
C	Capacitor, fixed or variable	R	Resistor, fixed or variable
CR	Diode, signal or rectifier	RT	Thermistor
DL	Delay line	S	Switch
DS	Indicating device (lamp)	T	Transformer
F	Fuse	TP	Test point
FL	Filter	U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
H	Heat dissipating device (heat sink, heat radiator, etc.)	V	Electron tube
HR	Heater	VR	Voltage regulator (zener diode, etc.)
J	Connector, stationary portion	Y	Crystal
K	Relay		
L	Inductor, fixed or variable		

VOLTAGE AND WAVEFORM TEST CONDITIONS

Typical voltage measurements were obtained under the following conditions unless noted otherwise on the individual diagrams:

Voltmeter

Type	Non-loading digital multimeter
Input impedance	10 M Ω
Range	0 to 1000 volts
Recommended type (as used for voltages on diagrams)	Tektronix 7D13 Digital Multimeter

7A18 (left vertical compartment)

DISPLAY MODE	ALT
TRIGGER SOURCE	MODE
CH 2 POLARITY	+UP

CH 1 and CH 2

VOLTS/DIV	10 mV
COUPLING	DC
POSITION	Centered
VARIABLE	CAL IN
Signal Applied	No signal for voltage measurements, 40 mV square wave from oscilloscope Calibrator applied to both input connectors for waveforms.

**7A16 (right vertical compartment
using a 10X probe with readout coding ring.
P6053 probe used for waveforms on diagrams)**

Polarity	+UP
Bandwidth	Full
Position	Centered
Coupling	AC
Variable	Cal In

7B70 (A Horizontal compartment)

Level/Slope	Centered on positive slope
Triggering	
Mode	P-P Auto
Coupling	AC
Source	Ext
Magnifier	X1
Time/Div	1 ms
Variable	Cal In
Ext Trig In connector	No connection for voltage measurements. For waveforms Sig Out from oscilloscope connected to Ext Trig In connector.

7704

Vertical Mode	Right
Horizontal Mode	A
A Intensity	Optimum
B Intensity	Counterclockwise
Calibrator	
Volts	40 mV
Rate	1 kHz
A Trigger Source	Right Vert
B Trigger Source	Left Vert

All voltages given on the diagrams are in volts. All currents are in milliamps. Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System. Vertical deflection factor shown on waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams (shown in blue) are not absolute and may vary between instruments because of component tolerances, internal calibration or front panel settings. Readouts are simulated in larger-than-normal type.

NOTE

The spring tension of the pin sockets ensures a good connection between the circuit board and pin. This spring tension may be damaged by using the pin sockets as a connecting point for spring-loaded probe tips, alligator clips, etc.

VOLTAGE AND WAVEFORM TEST CONDITIONS

Typical voltage measurements were obtained under the following conditions unless noted otherwise on the individual diagrams:

Voltmeter

Type	Non-loading digital multimeter
Input impedance	10 MΩ
Range	0 to 1000 volts
Recommended type (as used for voltages on diagrams)	Tektronix 7D13 Digital Multimeter

7A18 (left vertical compartment)

DISPLAY MODE	ALT
TRIGGER SOURCE	MODE
CH 2 POLARITY	+UP

CH 1 and CH 2

VOLTS/DIV	10 mV
COUPLING	DC
POSITION	Centered
VARIABLE	CAL IN
Signal Applied	No signal for voltage measurements, 40 mV square wave from oscilloscope Calibrator applied to both input connectors for waveforms.

7A16 (right vertical compartment

using a 10X probe with readout coding ring.
P6053 probe used for waveforms on diagrams)

Polarity	+UP
Bandwidth	Full
Position	Centered
Coupling	AC
Variable	Cal In

7B70 (A Horizontal compartment)

Level/Slope	Centered on positive slope
Triggering Mode	P-P Auto
Coupling	AC
Source	Ext
Magnifier	X1
Time/Div	1 ms
Variable	Cal In
Ext Trig In connector	No connection for voltage measurements. For waveforms Sig Out from oscilloscope connected to Ext Trig In connector.

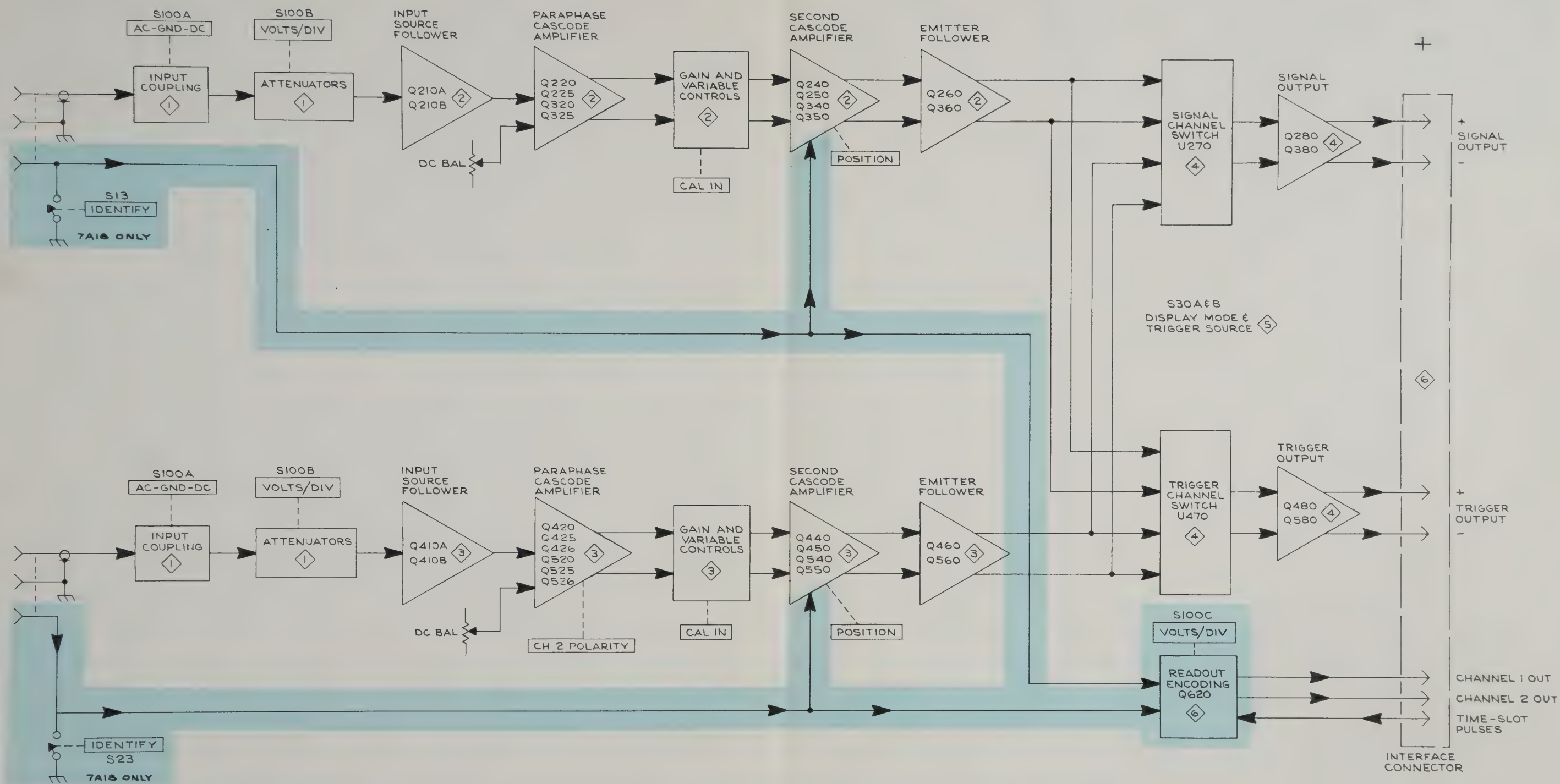
7704

Vertical Mode	Right
Horizontal Mode	A
A Intensity	Optimum
B Intensity	Counterclockwise
Calibrator	
Volts	40 mV
Rate	1 kHz
A Trigger Source	Right Vert
B Trigger Source	Left Vert

All voltages given on the diagrams are in volts. All currents are in milliamps. Waveforms shown are actual waveform photographs taken with a Tektronix Oscilloscope Camera System. Vertical deflection factor shown on waveform is the actual deflection factor from the probe tip. Voltages and waveforms on the diagrams (shown in blue) are not absolute and may vary between instruments because of component tolerances, internal calibration or front panel settings. Readouts are simulated in larger-than-normal type.

NOTE

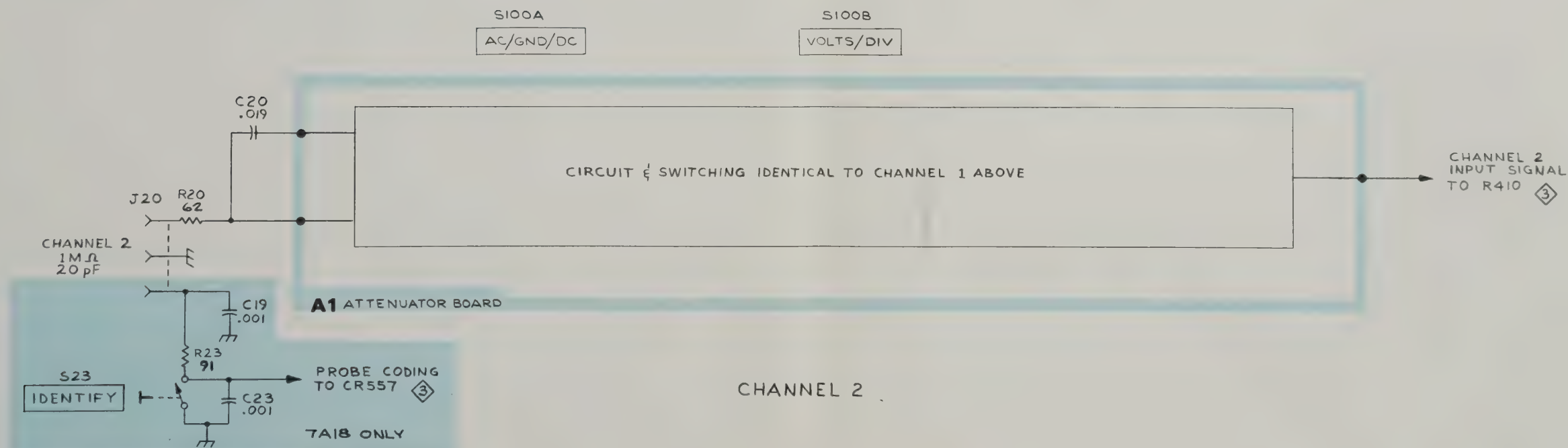
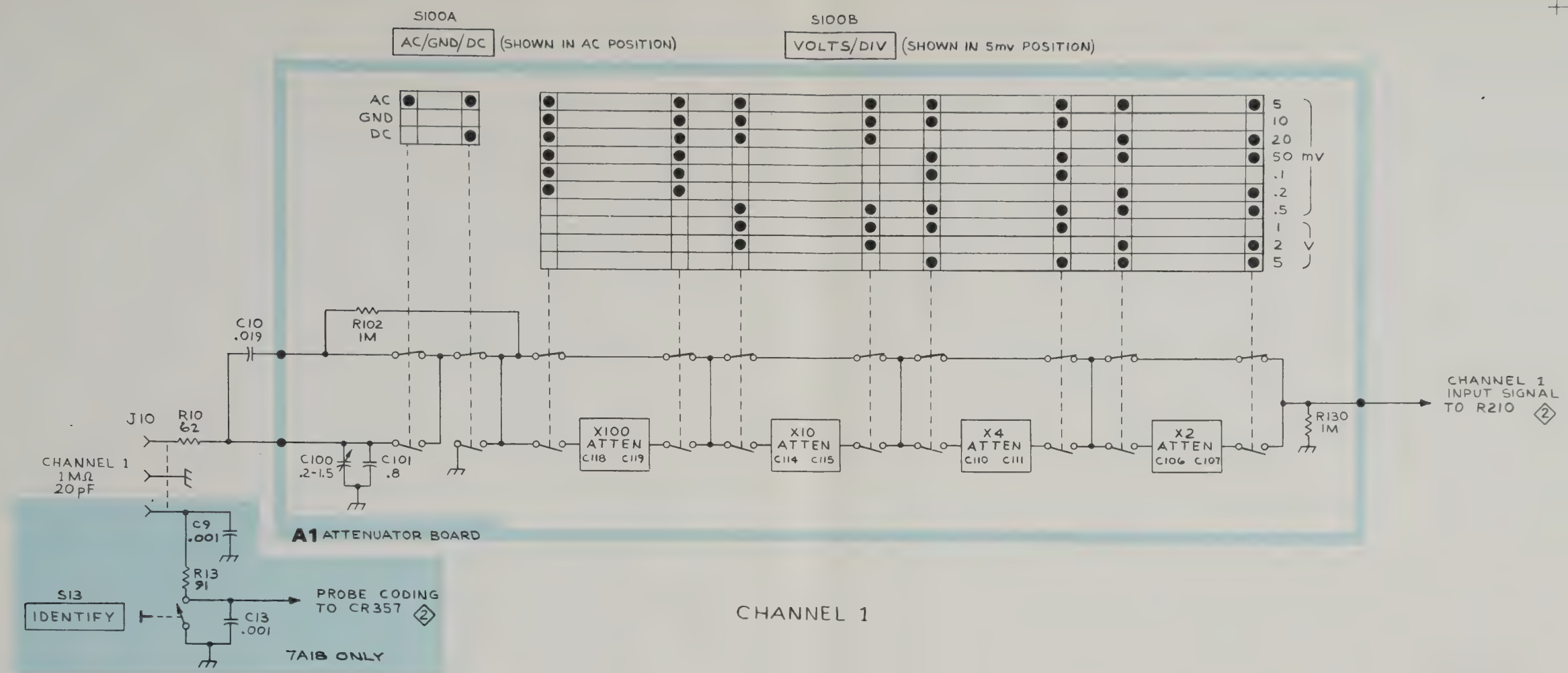
The spring tension of the pin sockets ensures a good connection between the circuit board and pin. This spring tension may be damaged by using the pin sockets as a connecting point for spring-loaded probe tips, alligator clips, etc.



7A18/7A18N

©

GRS/hq
1171
BLOCK DIAGRAM



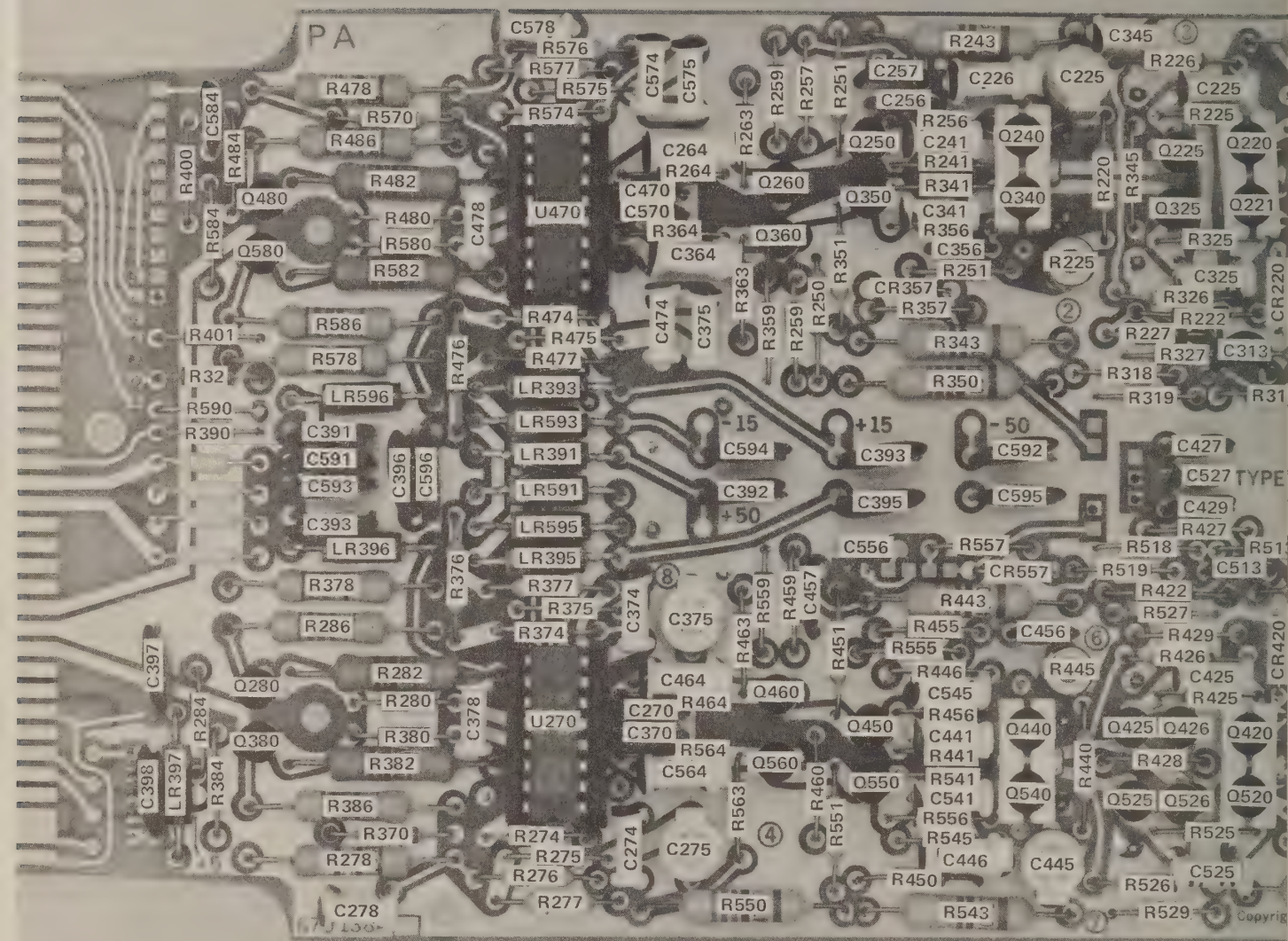
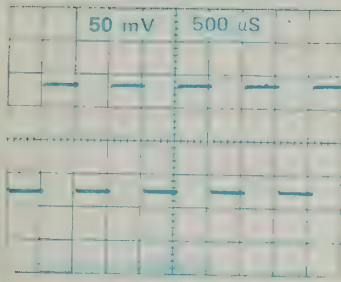
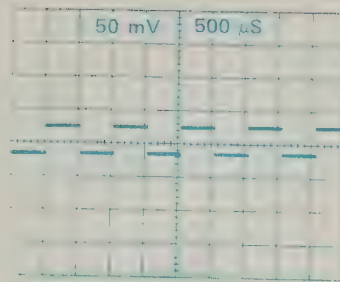


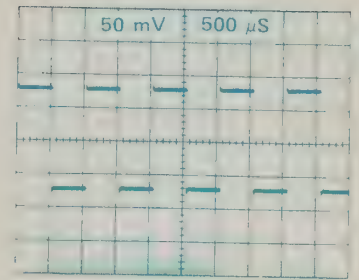
Fig. 7-1. A2 Amplifier Circuit Board Assembly (front view).



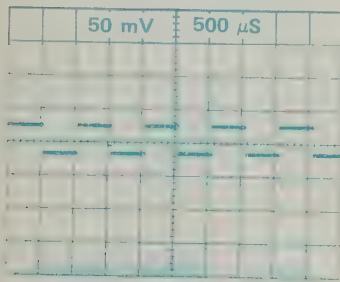
1



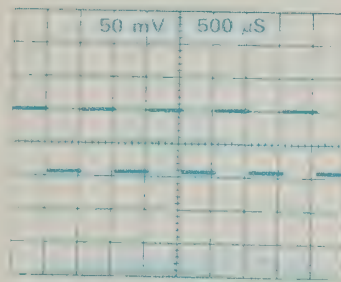
2



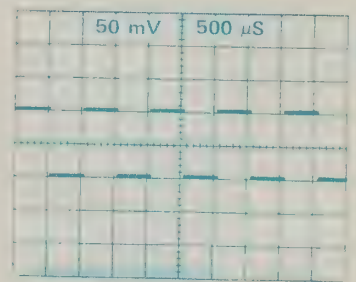
3



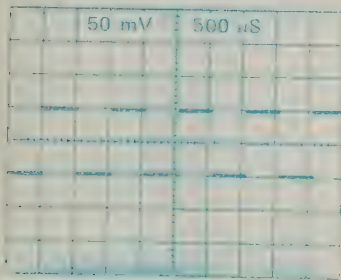
4



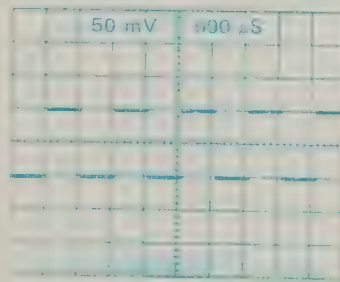
5



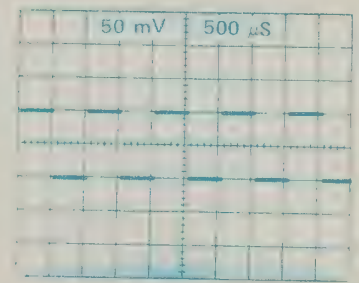
6



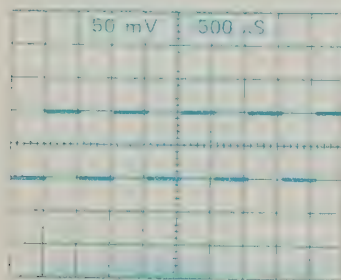
7



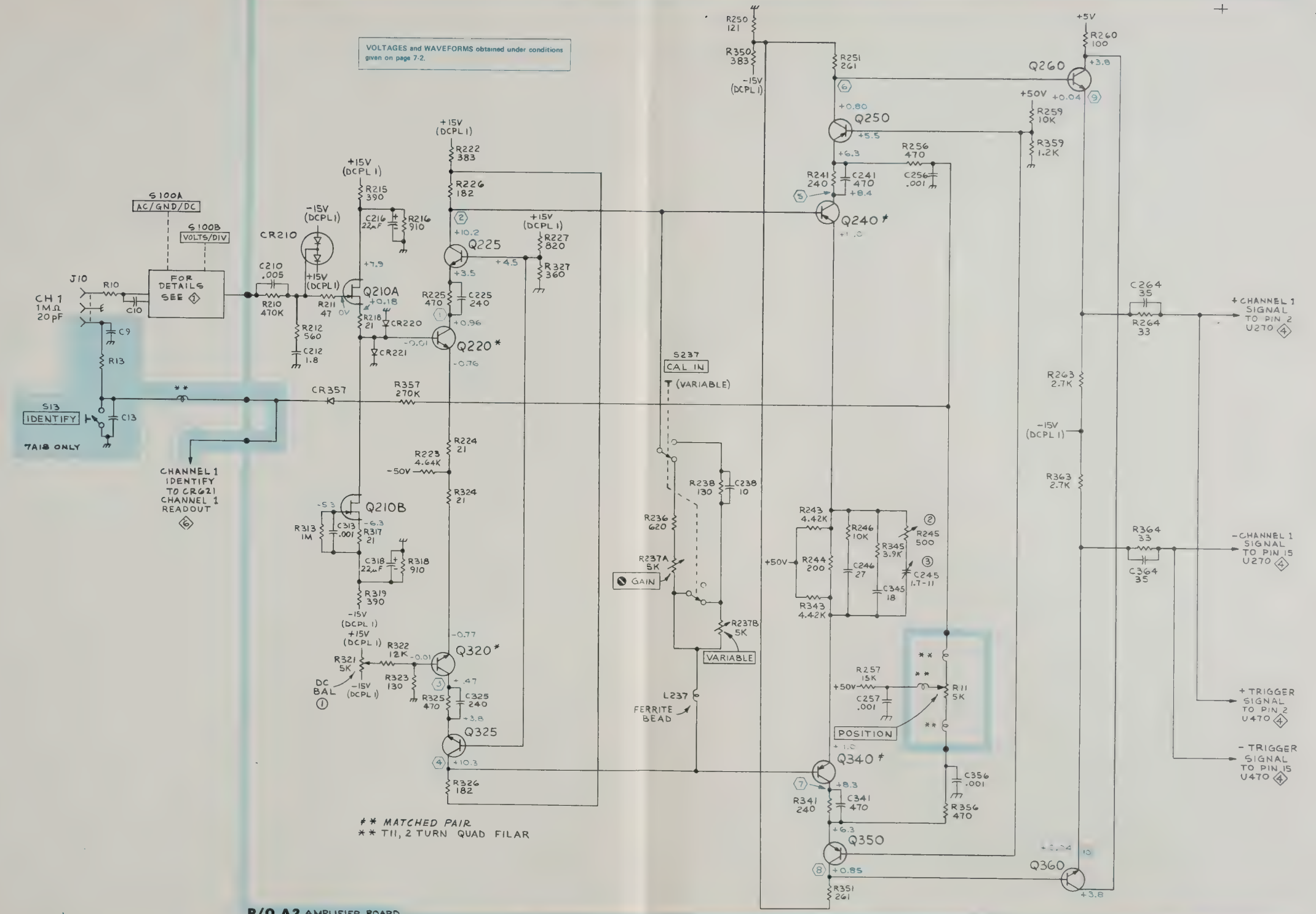
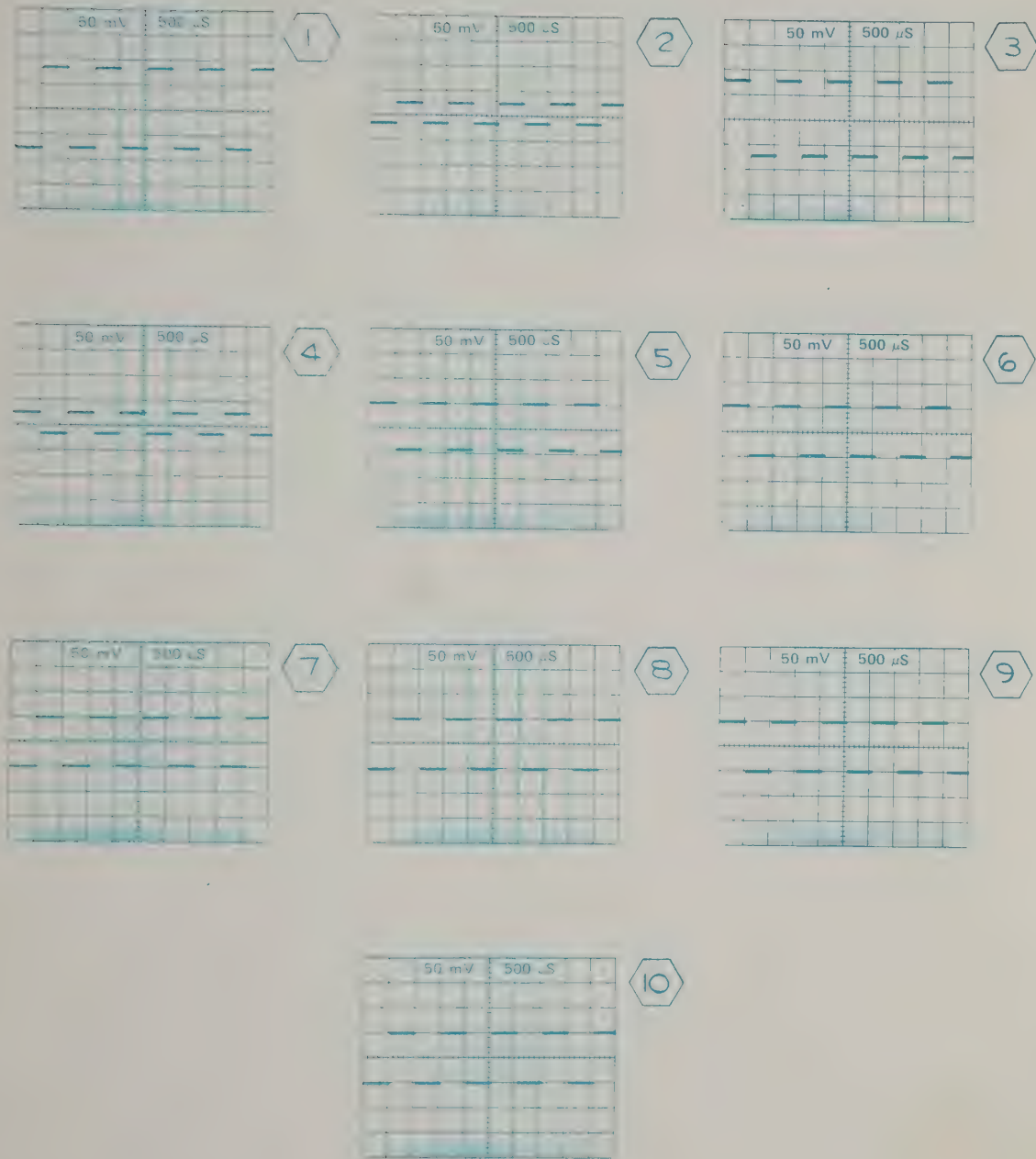
8

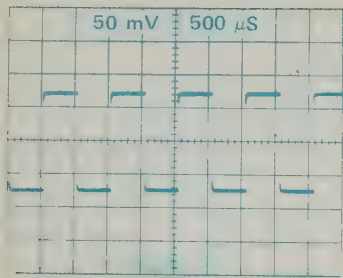


9

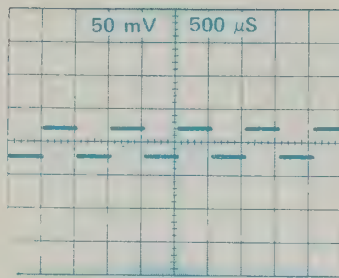


10

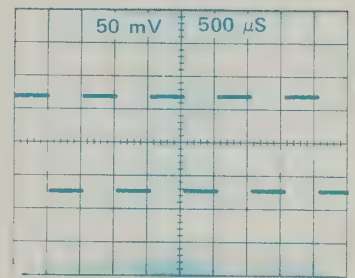




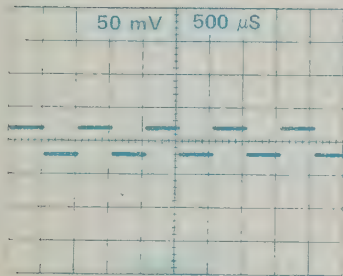
1



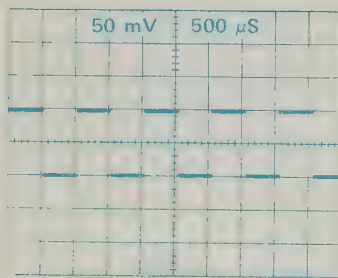
2



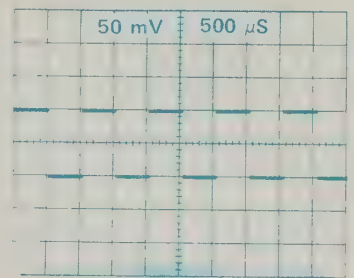
3



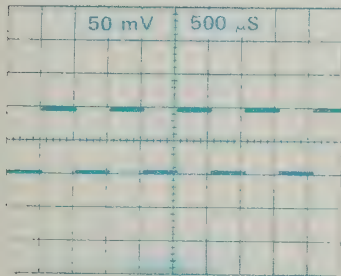
4



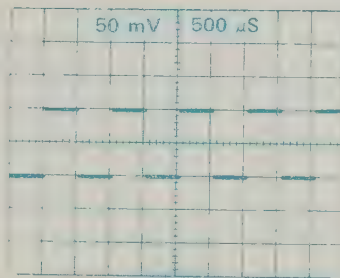
5



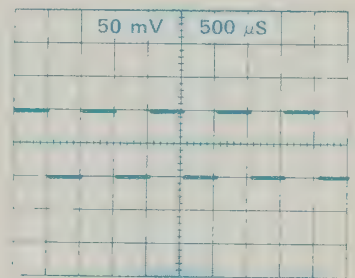
6



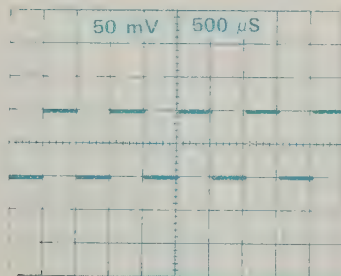
7



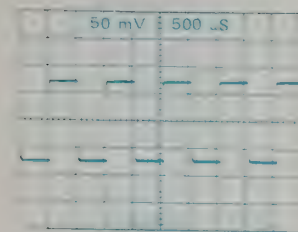
8



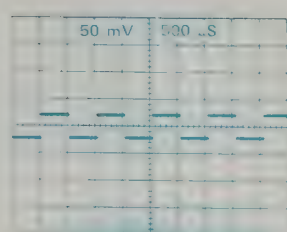
9



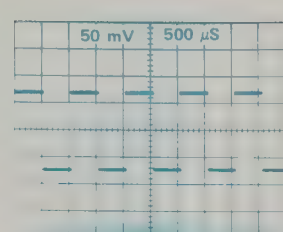
10



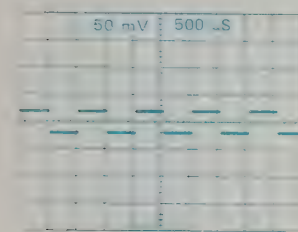
1



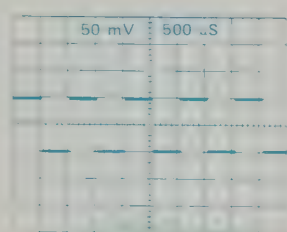
2



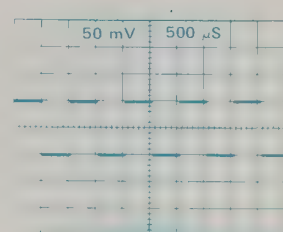
3



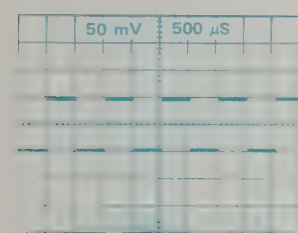
4



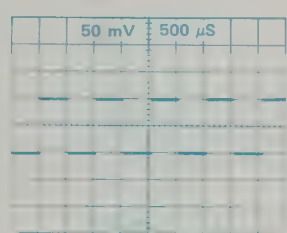
5



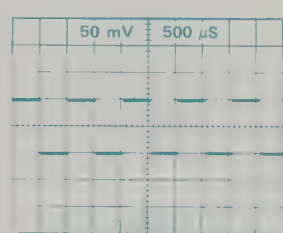
6



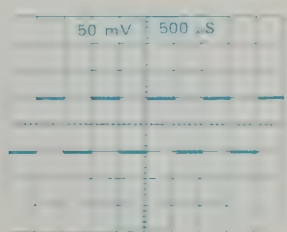
7



8

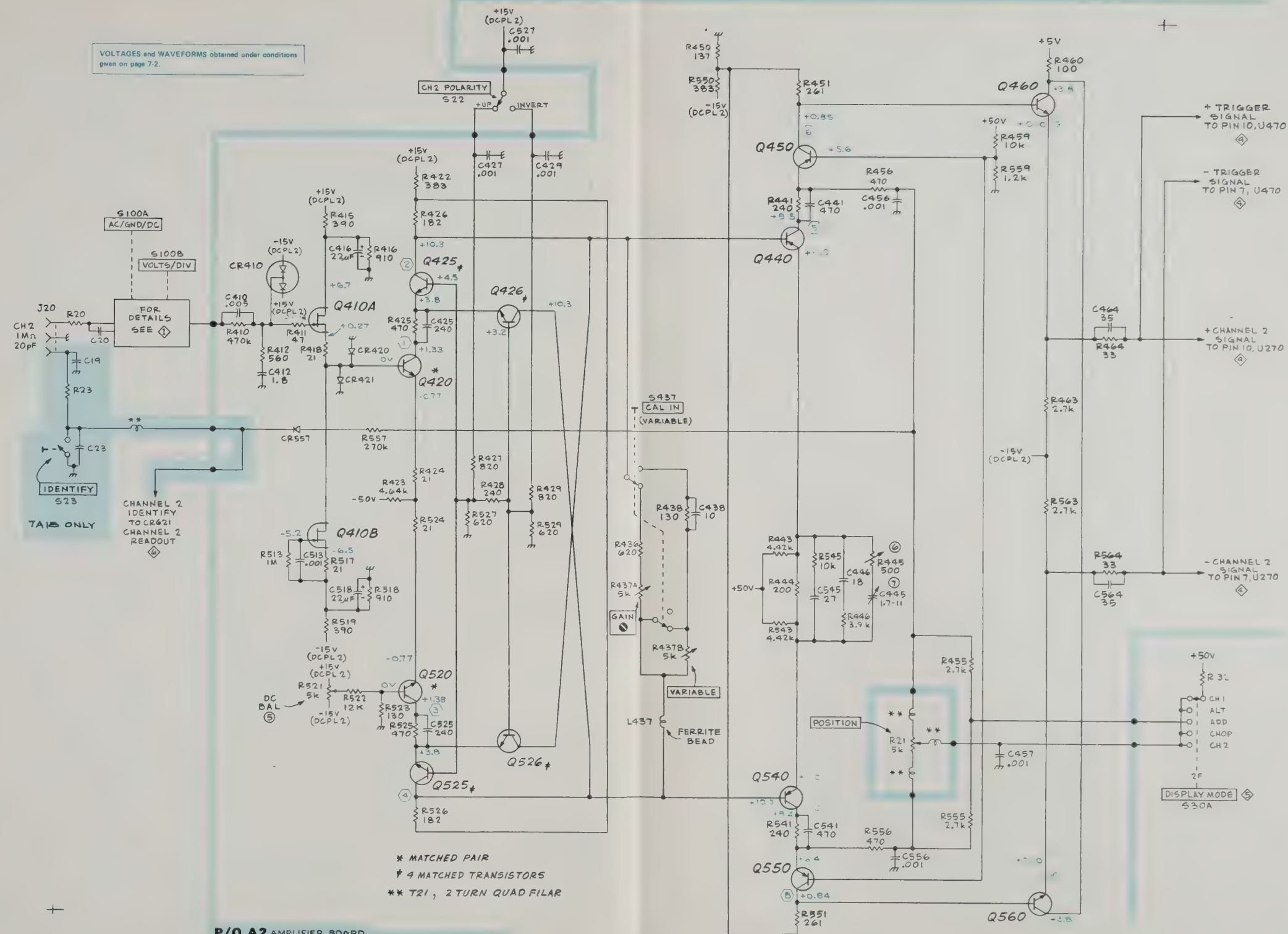


9



10

VOLTAGES and WAVEFORMS obtained under conditions given on page 7-2.

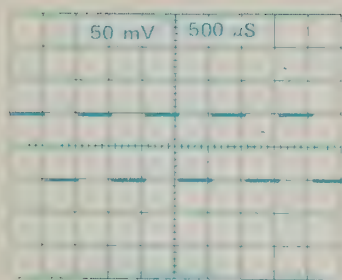


P/O A2 AMPLIFIER BOARD

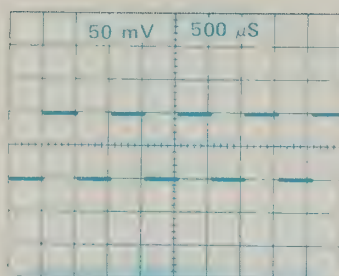
TA1B/TA1BN

CHANNEL 2 INPUT AMPLIFIER ③

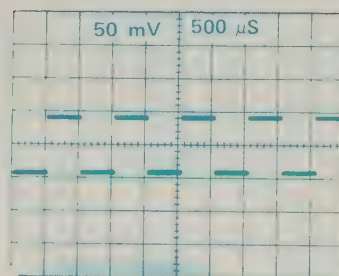
GAB/hq



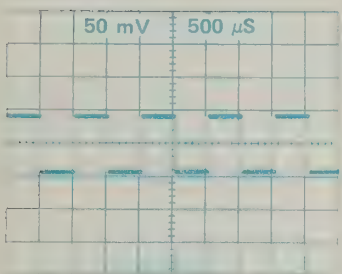
1



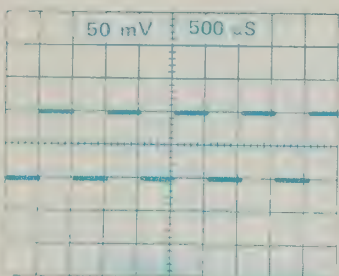
2



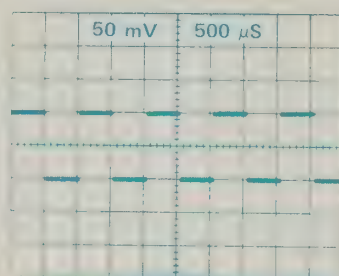
3



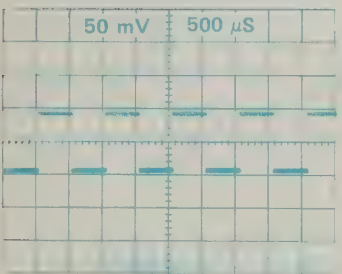
4



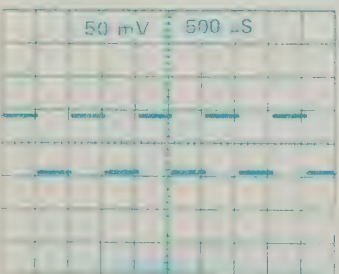
5



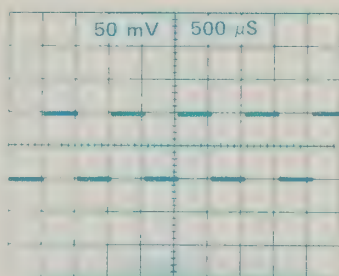
6



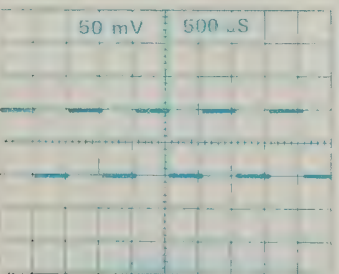
7



8



9



10

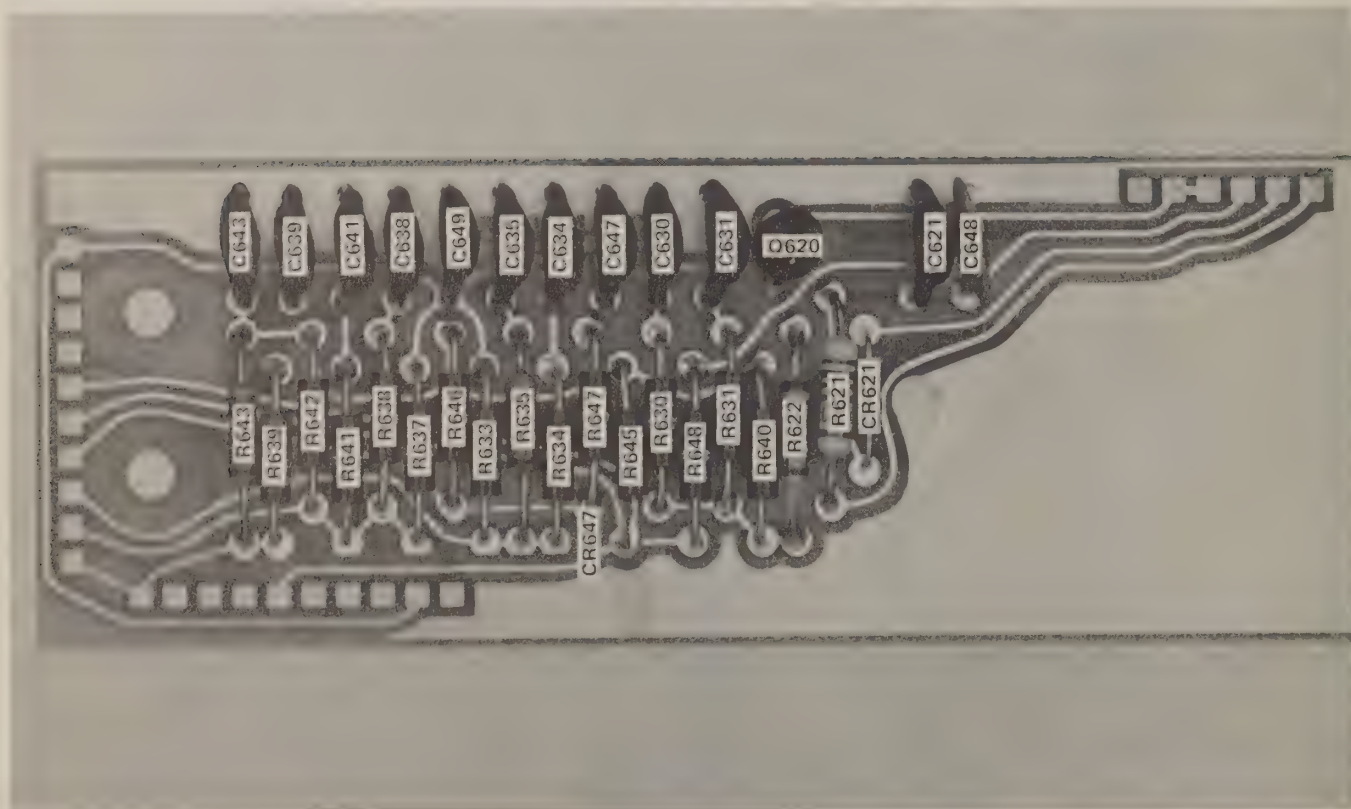


Fig. 7-3. A3 Readout Circuit Board Assembly.

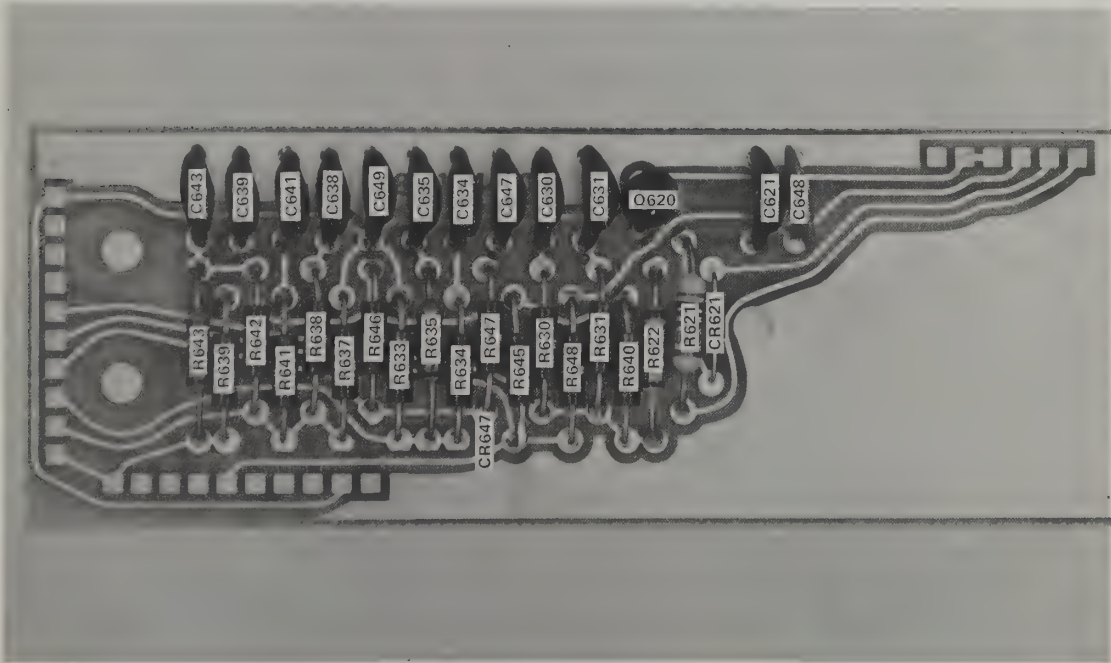


Fig. 7-3. A3 Readout Circuit Board Assembly.

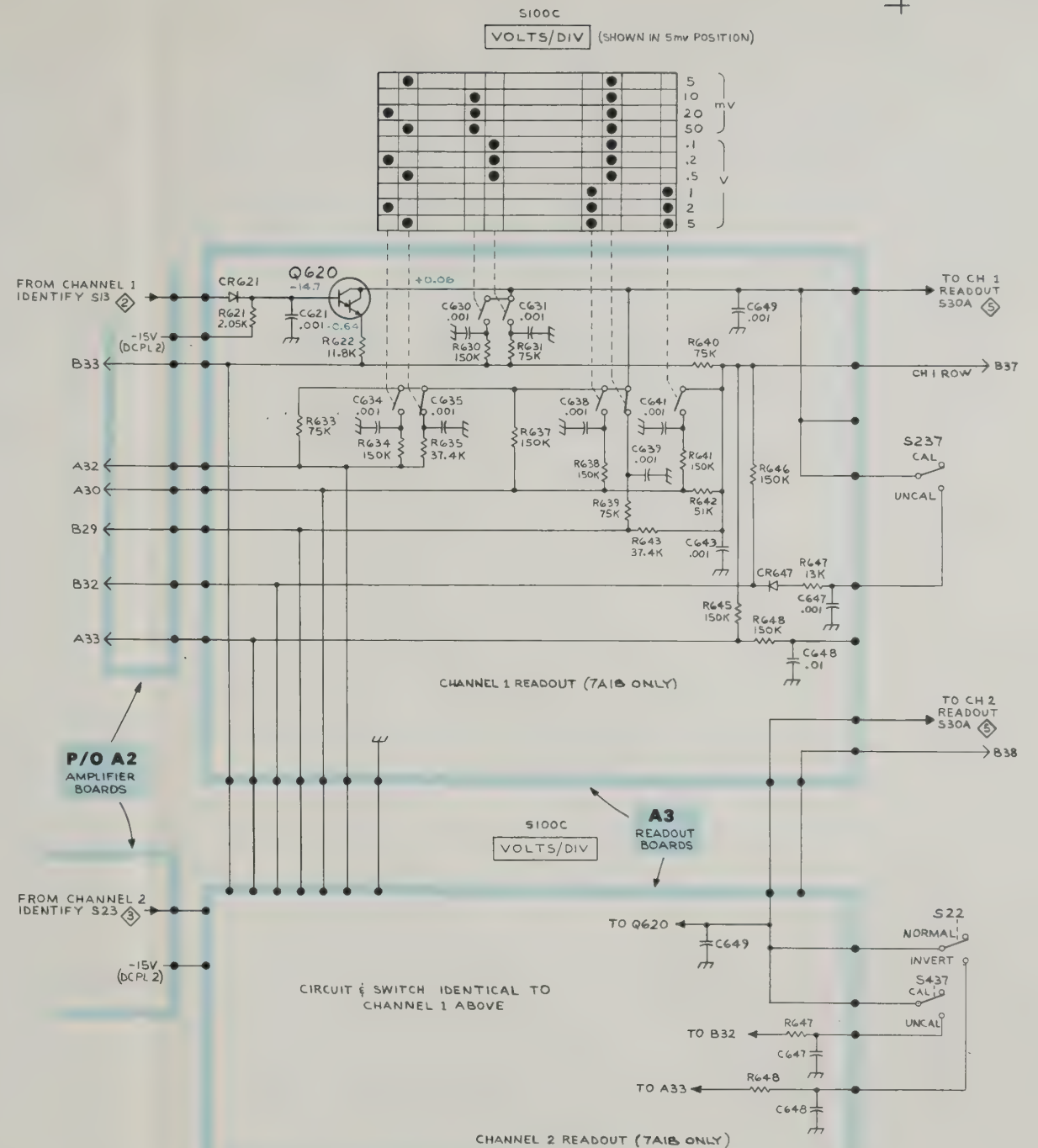
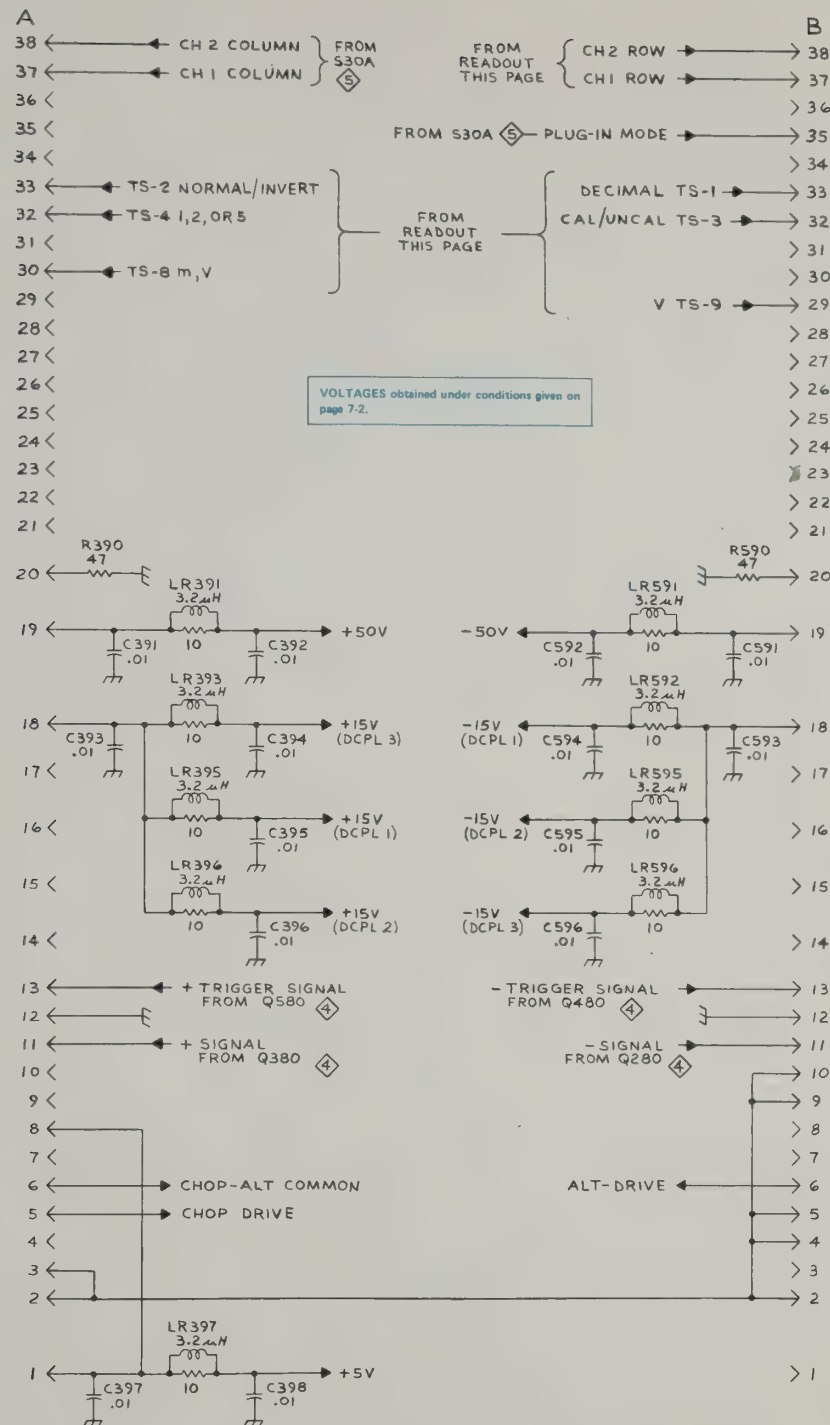


FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
 Detail Part of Assembly and/or Component
 mounting hardware for Detail Part
 Parts of Detail Part
 mounting hardware for Parts of Detail Part
 mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

SECTION 8

MECHANICAL PARTS LIST

7A18/7A18N

Replacement parts should be ordered from the Tektronix Field Office or Representative in your area. Changes to Tektronix products give you the benefit of improved circuits and components. Please include the instrument type number and serial number with each order for parts or service.

ABBREVIATIONS

BHB	binding head brass	h	height or high	OHB	oval head brass
BHS	binding head steel	hex.	hexagonal	OHS	oval head steel
CRT	cathode-ray tube	HHB	hex head brass	PHB	pan head brass
csk	countersunk	HHS	hex head steel	PHS	pan head steel
DE	double end	HSB	hex socket brass	RHS	round head steel
FHB	flat head brass	HSS	hex socket steel	SE	single end
FHS	flat head steel	ID	inside diameter	THB	truss head brass
Fil HB	fillister head brass	lg	length or long	THS	truss head steel
Fil HS	fillister head steel	OD	outside diameter	w	wide or width

FIGURE 1 EXPLODED,
STANDARD ACCESSORIES & INSTRUMENT OPTION

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q † y	1 2 3 4 5					Description
1-1	366-1163-00		1						KNOB, gray--TRIGGER SOURCE
	- - - - -		-						knob includes:
	213-0153-00		1						SETSCREW, 5-40 x 0.125 inch, HSS
-2	366-1165-00		1						KNOB, gray--DISPLAY MODE
	- - - - -		-						knob includes:
	213-0153-00 ¹		2						SETSCREW, 5-40 x 0.125 inch, HSS
-3	366-1059-00 ¹		2						KNOB, gray, push-on--IDENTIFY (CH1 & CH2)
-4	366-1077-00 ¹		2						KNOB, gray--POSITION (CH1 & CH2)
	- - - - -		-						each knob includes:
	213-0153-00 ²		1						SETSCREW, 5-40 x 0.125 inch, HSS
-5	366-0494-00 ²		2						KNOB, charcoal--POSITION
	- - - - -		-						each knob includes:
	213-0153-00		1						SETSCREW, 5-40 x 0.125 inch, HSS
-6	366-1308-00		2						KNOB, red--VARIABLE (CAL IN) CH1 & CH2
	- - - - -		-						each knob includes:
	213-0153-00		1						SETSCREW, 5-40 x 0.125 inch, HSS
-7	366-1299-00		2						KNOB, gray--VOLTS/DIV (CH1 & CH2)
	- - - - -		-						each knob includes:
	213-0153-00		2						SETSCREW, 5-40 x 0.125 inch, HSS
-8	366-0215-02 ¹		2						KNOB, lever switch
-9	366-1058-24 ¹		1						KNOB, latch
-10	366-1058-46 ²		1						KNOB, latch
	- - - - -		-						mounting hardware: (not included w/knob)
-11	214-1095-00		1						PIN, spring
-12	105-0076-00		1						RELEASE BAR, latch
-13	214-1280-00		1						SPRING, helical compression
-14	214-1054-00		1						SPRING, flat, latch detent
-15	105-0075-00		1						BODY, latch
-16	348-0235-00 ¹		2						SHIELDING GASKET
-17	333-1411-00 ¹		1						PANEL, front
-18	333-1596-00 ²		1						PANEL, front
-19	337-1064-00 ¹		2						SHIELD, electrical, side
-20	131-0679-00 ¹		2						CONNECTOR, receptacle, BNC
-21	131-0126-00 ²		2						CONNECTOR, receptacle, BNC
	- - - - -		-						mounting hardware for each: (not included w/connector)
-22	220-0569-00		1						NUT, knurled, 0.50-28 x 0.53 inch OD

¹7A18 only

²7A18N only

MECHANICAL PARTS LIST-7A18/7A18N

FIGURE 1 EXPLODED,
STANDARD ACCESSORIES & INSTRUMENT OPTION

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q † y	1 2 3 4 5					Description
1-23	358-0216-00		1						BUSHING, plastic
-24	- - - - -		2						RESISTOR, variable
-25	- - - - -		2						RESISTOR, variable, w/hardware
	- - - - -		-						mounting hardware for each: (not included w/resistor)
-26	210-0583-00		1						NUT, hex., 0.25-32 x 0.312 inch
-27	210-0011-00		1						WASHER, lock, internal, 0.25 ID x 0.468 OD (not shown)
-28	260-0816-00		1						SWITCH, slide--CH2 POLARITY
	- - - - -		-						mounting hardware: (not included w/switch)
-29	211-0030-00		2						SCREW, 2-56 x 0.25 inch, 82° csk, FHS
-30	210-0405-00		2						NUT, hex., 2-56 x 0.188 inch
-31	386-1447-54		1						SUBPANEL, front
	- - - - -		-						mounting hardware: (not included w/subpanel)
-32	213-0192-00		4						SCREW, thread forming, 6-32 x 0.50 inch, F11 HS
-33	- - - - -		1						CIRCUIT BOARD ASSEMBLY--AMPLIFIER A2
	- - - - -		-						circuit board assembly includes:
	388-1943-01		1						CIRCUIT BOARD
-34	136-0252-04		88						SOCKET, pin connector
-35	131-0566-00		4						LINK, terminal connecting
-36	200-0945-00		4						COVER HALF, temperature stabilizer
-37	200-0945-01		4						COVER HALF, temperature stabilizer, threaded
-38	211-0001-00		4						SCREW, 2-56 x 0.25 inch, RHS
-39	136-0260-01		2						SOCKET, integrated circuit, 16 pin
-40	124-0162-00		2						TERMINAL STRIP, ceramic, 0.438 inch h, w/4 notches
	- - - - -		-						each terminal strip includes:
-41	355-0046-00		1						STUD, plastic, 0.75 inch long
-42	262-0928-00		2						SWITCH, push--GAIN (CH1 & CH2), wired
	- - - - -		-						mounting hardware for each: (not included w/switch)
-43	210-0583-00		1						NUT, hex., 0.25-32 x 0.312 inch
-44	210-0046-00		1						WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-45	262-0926-00		1						SWITCH, rotary--TRIG SOURCE/DISP MODE, wired
	- - - - -		-						switch includes:
	260-1221-00		1						SWITCH, rotary
-46	175-0825-00		ft						WIRE, electrical, 2 wire ribbon, 4 inches long
-47	175-0828-00		ft						WIRE, electrical, 5 wire ribbon, 3.50 inches long
-48	175-0830-00		ft						WIRE, electrical, 7 wire ribbon, 3.50 inches long
	- - - - -		-						mounting hardware: (not included w/switch)
-49	210-0590-00		1						NUT, hex., 0.375-32 x 0.438 inch
-50	210-0012-00		1						WASHER, lock, internal, 0.375 ID x 0.50 inch OD
-51	407-0553-00		2						BRACKET, component mounting, 0.853 inch h
-52	407-0912-00		1						BRACKET, component mounting
-53	376-0039-00		2						COUPLING, shaft, 0.312 OD x 0.438 inch long
	- - - - -		-						coupling includes:
	213-0075-00		2						SETSCREW, 4-40 x 0.094 inch, HSS

¹7A18 only²7A18N only³Refer to Electrical Parts List for part number.

FIGURE 1 EXPLODED
STANDARD ACCESSORIES & INSTRUMENT OPTION (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q † y	1 2 3 4 5					Description
1-54	376-0125-00		2						COUPLER, switch
	---		-						mounting hardware for each: (not included w/coupler)
	213-0048-00		2						SETSCREW, 4-40 x 0.125 inch, HSS
	354-0251-00		1						RING, coupling, 0.251 ID x 0.375 inch OD
-55	376-0124-00		2						COUPLER DRIVER, switch
	---		-						mounting hardware for each: (not included w/coupler)
	213-0048-00		2						SETSCREW, 4-40 x 0.125 inch, HSS
	354-0251-00		1						RING, coupling, 0.251 ID x 0.375 inch OD
	---		-						mounting hardware: (not included w/circuit board assembly)
-56	211-0116-00		4						SCREW, sems, 4-40 x 0.312 inch, PHB
-57	211-0105-00		4						SCREW, 4-40 x 0.188 inch, 100° csk, FHS
-58	220-0547-01		4						NUT BLOCK
-59	200-1199-00		2						COVER, attenuator
	---		-						mounting hardware for each: (not included w/cover)
-60	211-0007-00		4						SCREW, 4-40 x 0.188 inch, PHS
-61	210-0994-00		4						WASHER, flat, 0.125 ID x 0.25 inch OD
-62	131-1075-00		1						CONTACT, electrical, grounding
-63	210-0288-00		2						TERMINAL, lug, 0.125 ID x 1.125 inches long
	---		-						mounting hardware for each: (not included w/terminal)
-64	210-0586-00		1						NUT, keps, 4-40 x 0.25 inch
-65	211-0101-		1						SCREW, 4-40 x 0.25 inch, 100° csk, FHS
-66	407-0906-00		1						BRACKET, circuit board
	---		-						mounting hardware: (not included w/bracket)
-67	211-0116-00		2						SCREW, sems, 4-40 x 0.312 inch, PHB
-68	210-0586-00		2						NUT, keps, 4-40 x 0.25 inch
-69	337-1423-00		2						SHIELD, attenuator, front
	---		-						mounting hardware for each: (not included w/shield)
-70	213-0055-00		1						SCREW, thread forming, 2-32 x 0.188 inch, PHS
	672-0020-00 ¹		2						CIRCUIT BOARD ASSEMBLY--ATTENUATOR/READOUT
	--- ^{2,3}		2						CIRCUIT BOARD ASSEMBLY--ATTENUATOR A1
	---		-						each circuit board assembly includes:
-71	200-1277-00 ²		1						COVER, cam switch
	---		-						mounting hardware: (not included w/cover)
-72	211-0016-00 ¹		6						SCREW, sems, 4-40 x 0.312 inch, PHB
-73	---		1						CIRCUIT BOARD ASSEMBLY--READOUT A3
	---		-						circuit board assembly includes:
-74	388-1944-00		1						CIRCUIT BOARD
-75	136-0252-04		3						SOCKET, pin connector
-75	210-0799-00		7						EYELET
-76	131-1031-00		7						CONTACT ASSEMBLY, top
	---		-						mounting hardware: (not included w/circuit board assembly)
-77	211-0116-00		6						SCREW, sems, 4-40 x 0.312 inch, PHB

¹7A18 only²7A18N only³Refer to Electrical Parts List for part number.

MECHANICAL PARTS LIST-7A18/7A18N

FIGURE 1 EXPLODED
STANDARD ACCESSORIES & INSTRUMENT OPTION (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q t y						Description
				1	2	3	4	5	
1-78	337-1418-01 ¹		2						SHIELD, electrical, cam switch
	- - - - -		-						mounting hardware for each: (not included w/shield)
-79	211-0180-00		3						SCREW, sems, 2-56 x 0.25 inch, PHB
-80	337-1406-00		1						SHIELD, electrical
-81	105-0243-00		1						LEVER, switch
-82	354-0391-00		2						RING, retaining
-83	401-0081-02		2						BEARING, rear
	210-0591-00		12						NUT, hex., 4-40 x 0.188 inch
-84	214-1139-00 ²		-						SPRING, flat, gold
	214-1139-02 ²		-						SPRING, flat, green
	214-1139-03 ²		-						SPRING, flat, red
-85	105-0242-00		1						DRUM, cam switch, AC GND DC
-86	105-0241-00		1						DRUM, cam switch, VOLTS/DIV
-87	401-0115-00		1						BEARING, center
-88	441-0992-00		1						CHASSIS
	- - - - -		-						mounting hardware: (not included w/chassis)
-89	211-0097-00		2						SCREW, 4-40 x 0.312 inch, PHS
-90	210-0004-00		2						WASHER, lock, internal, 0.12 ID x 0.26 inch OD
-91	129-0299-00		4						POST, hex., 4-40 x 0.188 x 0.335 inch long
	- - - - -		-						mounting hardware for each: (not included w/post)
-92	210-0004-00		1						WASHER, lock, internal, 0.12 ID x 0.26 inch OD
-93	214-1127-00		4						ROLLER, detent
-94	210-0591-00		10						NUT, hex., 4-40 x 0.188 inch
-95	136-0252-00		8						SOCKET, pin connector
-96	210-0779-00		10						EYELET
-97	131-1031-00		10						CONTACT ASSEMBLY, top
-98	131-1030-00		10						CONTACT ASSEMBLY, bottom
-99	388-1945-00		1						CIRCUIT BOARD--ATTENUATOR
	- - - - -		-						mounting hardware: (not included w/circuit board)
-100	213-0120-00		3						SCREW, thread forming, 2-32 x 0.25 inch, PHS
-101	210-0053-00		3						WASHER, lock, split, 0.092 ID x 0.175 inch OD
-102	210-1134-00		3						WASHER, flat, 0.09 ID x 0.25 inch OD
	- - - - -		-						mounting hardware for each: (not included w/circuit board assembly)
-103	211-0008-00 ¹		2						SCREW, 4-40 x 0.25 inch, PHS
-104	129-0080-01 ¹		1						POST, 4-40 x 0.875 inch long
-105	386-1402-00		1						PANEL, rear
	- - - - -		-						mounting hardware: (not included w/panel)
-106	213-0192-00		4						SCREW, thread forming, 6-32 x 0.50 inch, Fil HS
-107	361-0326-00		1						SPACER, sleeve, 0.18 ID x 0.25 OD x 0.10 inch long

¹7A18 only²Replace only with part bearing the same color code as the original part in your instrument.

MECHANICAL PARTS LIST--7A18/7A18N

FIGURE 1 EXPLODED
STANDARD ACCESSORIES & INSTRUMENT OPTION (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Disc	Q t y	1 2 3 4 5					Description
1-54	376-0125-00		2						COUPLER, switch
	- - - - -		-						mounting hardware for each: (not included w/coupler)
	213-0048-00		2						SETSCREW, 4-40 x 0.125 inch, HSS
	354-0251-00		1						RING, coupling, 0.251 ID x 0.375 inch OD
-55	376-0124-00		2						COUPLER DRIVER, switch
	- - - - -		-						mounting hardware for each: (not included w/coupler)
	213-0048-00		2						SETSCREW, 4-40 x 0.125 inch, HSS
	354-0251-00		1						RING, coupling, 0.251 ID x 0.375 inch OD
	- - - - -		-						mounting hardware: (not included w/circuit board assembly)
-56	211-0116-00		4						SCREW, sems, 4-40 x 0.312 inch, PHB
-57	211-0105-00		4						SCREW, 4-40 x 0.188 inch, 100° csk, FHS
-58	220-0547-01		4						NUT BLOCK
-59	200-1199-00		2						COVER, attenuator
	- - - - -		-						mounting hardware for each: (not included w/cover)
-60	211-0007-00		4						SCREW, 4-40 x 0.188 inch, PHS
-61	210-0994-00		4						WASHER, flat, 0.125 ID x 0.25 inch OD
-62	131-1075-00		1						CONTACT, electrical, grounding
-63	210-0288-00		2						TERMINAL, lug, 0.125 ID x 1.125 inches long
	- - - - -		-						mounting hardware for each: (not included w/terminal)
-64	210-0586-00		1						NUT, keps, 4-40 x 0.25 inch
-65	211-0101-		1						SCREW, 4-40 x 0.25 inch, 100° csk, FHS
-66	407-0906-00		1						BRACKET, circuit board
	- - - - -		-						mounting hardware: (not included w/bracket)
-67	211-0116-00		2						SCREW, sems, 4-40 x 0.312 inch, PHB
-68	210-0586-00		2						NUT, keps, 4-40 x 0.25 inch
-69	337-1423-00		2						SHIELD, attenuator, front
	- - - - -		-						mounting hardware for each: (not included w/shield)
-70	213-0055-00		1						SCREW, thread forming, 2-32 x 0.188 inch, PHS
	672-0020-00 ¹		2						CIRCUIT BOARD ASSEMBLY--ATTENUATOR/READOUT
	- - - - - ^{2,3}		2						CIRCUIT BOARD ASSEMBLY--ATTENUATOR A1
	- - - - -		-						each circuit board assembly includes:
-71	200-1277-00 ²		1						COVER, cam switch
	- - - - -		-						mounting hardware: (not included w/cover)
-72	211-0016-00 ¹		6						SCREW, sems, 4-40 x 0.312 inch, PHB
-73	- - - - -		1						CIRCUIT BOARD ASSEMBLY--READOUT A3
	- - - - -		-						circuit board assembly includes:
	388-1944-00		1						CIRCUIT BOARD
-74	136-0252-04		3						SOCKET, pin connector
-75	210-0799-00		7						EYELET
-76	131-1031-00		7						CONTACT ASSEMBLY, top
	- - - - -		-						mounting hardware: (not included w/circuit board assembly)
-77	211-0116-00		6						SCREW, sems, 4-40 x 0.312 inch, PHB

¹7A18 only²7A18N only³Refer to Electrical Parts List for part number.

FIGURE 1 EXPLODED
STANDARD ACCESSORIES & INSTRUMENT OPTION (cont)

²Replace only with part bearing the same color code as the original part in your instrument.

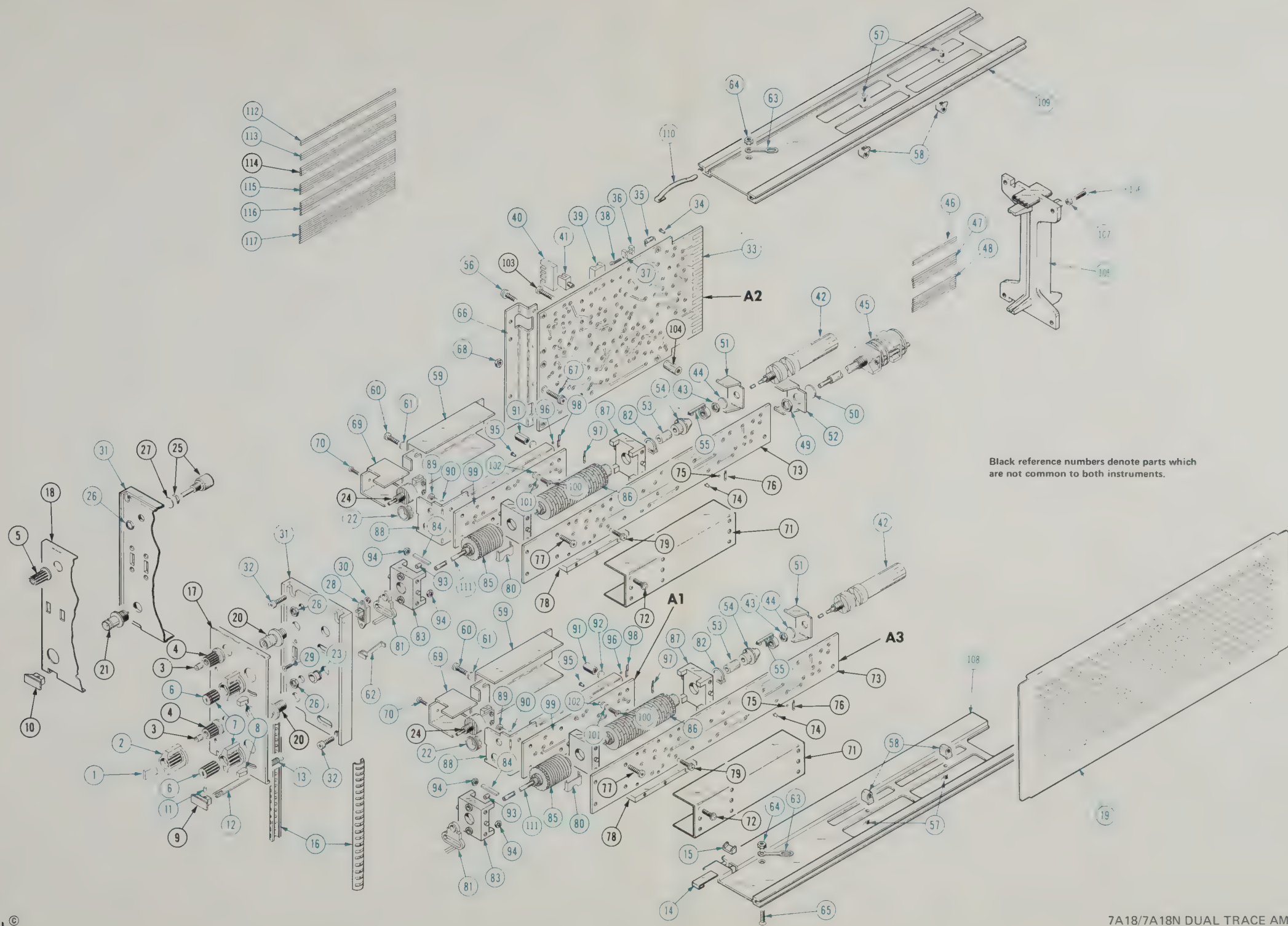
FIGURE 1 EXPLODED
STANDARD ACCESSORIES & INSTRUMENT OPTION (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Q					Description	
				t	y	1	2	3		4
1-108	426-0737-00			1						FRAME SECTION, bottom
-109	426-0736-00			1						FRAME SECTION, top
-110	214-1061-00			1						SPRING, flat, sliding ground
-111	384-1078-00			2						SHAFT, extension, 7.322 inches long
-112	175-0825-00			ft						WIRE, electrical, 2 wire ribbon, 24 inches long
-113	175-0826-00			ft						WIRE, electrical, 3 wire ribbon, 8.50 inches long
	175-0826-00 ¹			ft						WIRE, electrical, 3 wire ribbon, 9.50 inches long
-114	175-0827-00 ²			ft						WIRE, electrical, 4 wire ribbon, 10.50 inches long
-115	175-0828-00			ft						WIRE, electrical, 5 wire ribbon, 3 inches long
-116	175-0829-00			ft						WIRE, electrical, 6 wire ribbon, 3 inches long
-117	175-0832-00			ft						WIRE, electrical, 9 wire ribbon, 3.50 inches long

STANDARD ACCESSORIES

070-1126-01 1 MANUAL, instruction (not shown)

¹7A18N only
²7A18 only



CARTON ASSEMBLY
(Part No. 065-0125-00)

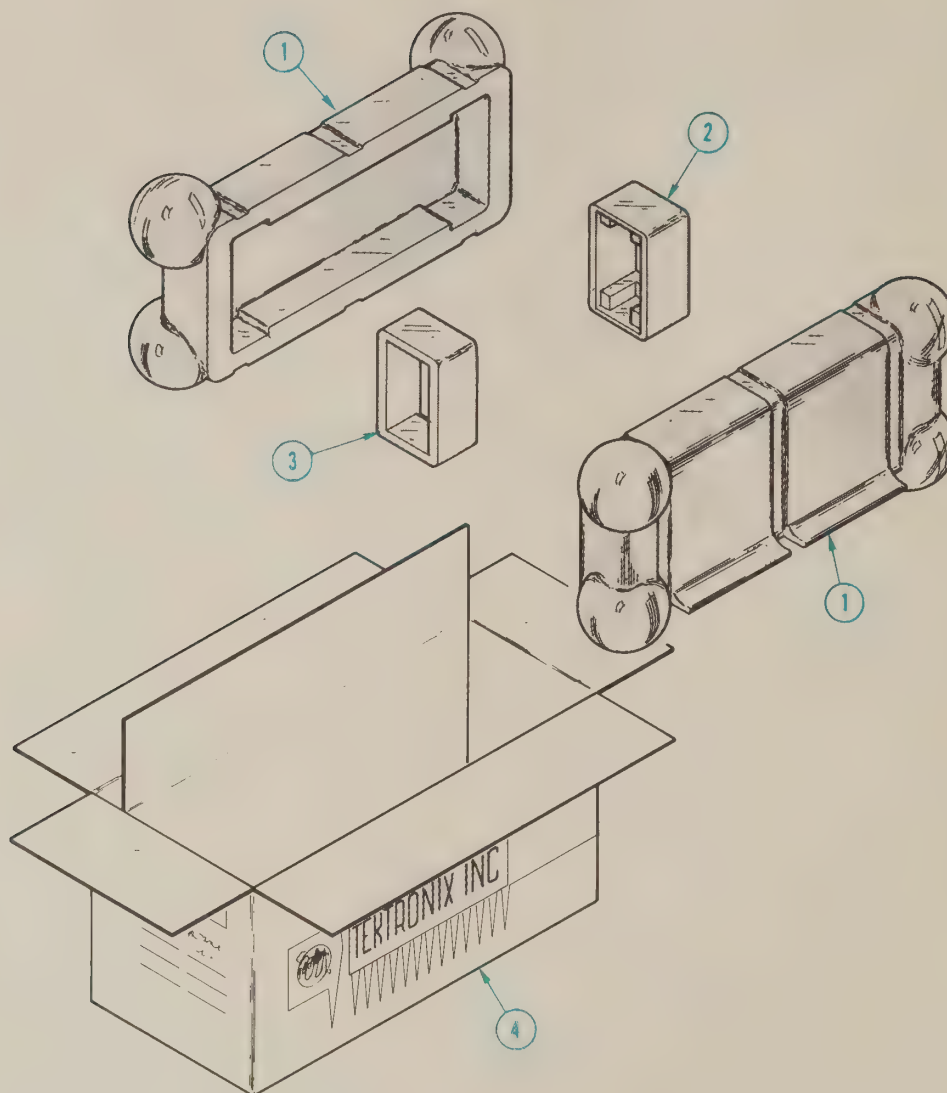


Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y					Description
				1	2	3	4	5	
2-	065-0125-00			1					ASSEMBLY, carton
-1	004-0241-00			-					assembly includes:
-2	004-0242-00			2					CASE HALF
-3	004-0243-00			1					END CAP, rear
-4	004-0748-00			1					END CAP, front
				1					CARTON

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

FIG. 2 REPACKAGING

+

CARTON ASSEMBLY
(Part No. 065-0125-00)

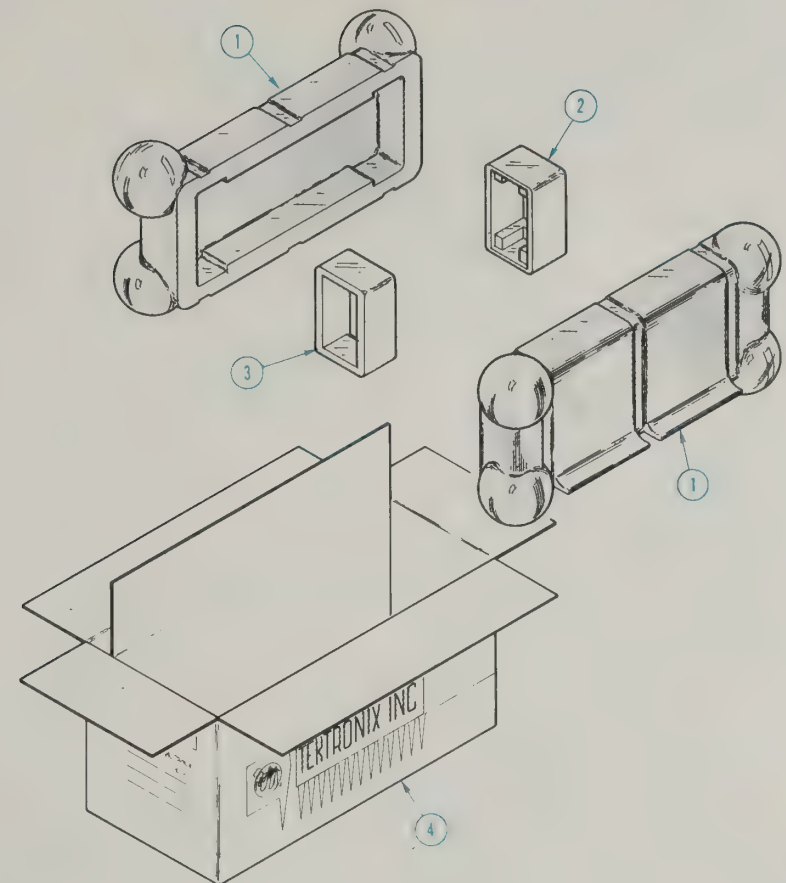


Fig. & Index No.	Tektronix Part No.	Serial/Model Eff	No. Disc	Q t y						Description
					1	2	3	4	5	
2-	065-0125-00	-	-	1						ASSEMBLY, carton
-1	004-0241-00	-	-	2						assembly includes: CASE HALF
-2	004-0242-00	-	-	1						END CAP, rear
-3	004-0243-00	-	-	1						END CAP, front
-4	004-0748-00	-	-	1						CARTON

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

